Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Alabama

Pasture Grazing Best Management Practices Result in Pathogen (Fecal Coliform) Delisting

Waterbody Improved Runoff from grazing activities contributed to pathogen (fecal coliform [FC]) impairments of Caney Branch in Baldwin County, Alabama. Implementing best management practices (BMPs) including livestock exclusion fencing, stream crossings, and riparian buffers helped Caney Branch meet its designated water use classification of *Fish & Wildlife*. As a result, the Alabama Department of Environmental Management (ADEM) removed the 5-mile impaired segment of Caney Branch from the state's section 303(d) list of impaired waters in 2002.

Problem

Caney Branch is a tributary of the Fish River, which originates near the city of Stapleton and flows south through Baldwin County before emptying into Weeks Bay in southwest Alabama (Figure 1). The U.S. Environmental Protection Agency (EPA) designated Weeks Bay as a National Estuarine Research Reserve in 1986, and ADEM designated it as an Outstanding National Resource Water in 1992.

Table 1. Geological Survey of Alabama sample results (Site 8-A)

Year	# of Samples	Exceedances
1994	10	5
1995	12	2
1996	12	1
1997	12	0
1998	12	1
Total	58	9

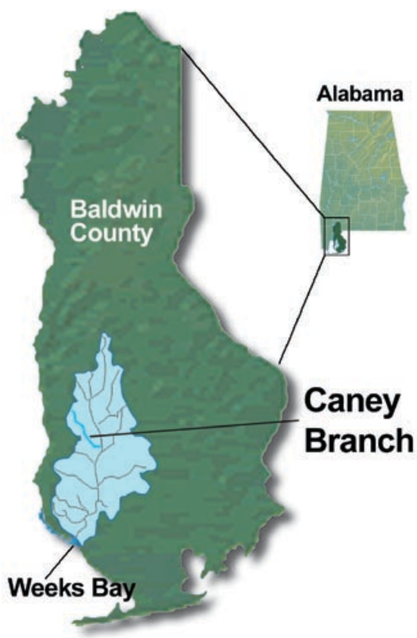

Figure 1. Location of Caney Branch in Baldwin County, Alabama.

Land use/land cover in the Caney Branch subwatershed is primarily cropland, pasture/hayland, and forest lands. FC contamination problems associated with cattle grazing practices, unrestricted stream access, and trampling of riparian vegetation was well documented in the watershed. The Geological Survey of Alabama used section 319 funds to collect 58 monthly FC samples between 1994 and 1998. The median FC count was 230 col/100 milliliters (mL) (range of 30 to 83,000 col/100 mL) with nine samples (15 percent) exceeding the Fish & Wildlife single sample criterion of 2,000 col/100 mL (Table 1). As a result, ADEM placed this 5-mile segment of Caney Branch on the state's 1998 and 2000 303(d) lists of impaired waters. The impairment cause was listed as pathogens, and the sources of impairment were identified as pasture grazing/riparian.

Project Highlights

The Natural Resources Conservation Service, ADEM, EPA–Gulf of Mexico Program, and other stakeholders used a section 319 grant to initiate the Fish River Watershed Project, which was eventually expanded to become the Weeks Bay Watershed Project. The project focus was to holistically assess water quality, lessen cumulative effects of runoff, and address threats to the Weeks Bay watershed.

The partners installed BMPs including livestock exclusion fencing, riparian buffers, and stream crossings. They also conducted education and outreach efforts throughout the Caney Branch Watershed, including cleanups, field days, workshops, and stakeholder meetings. These efforts helped to achieve the goals of the Weeks Bay National Estuarine Research Reserve Management Plan and the Weeks Bay Watershed Management Plan.

Results

In 2001 ADEM collected 22 samples at Caney Branch Site CNYB-1 (Table 2). No single sample value exceeded the Fish & Wildlife criterion of 2,000 col/100 mL, and no geometric mean value exceeded the October to May geometric mean criterion of 1,000 col/100mL.

Also, the Weeks Bay Project coordinator collected two series of five FC samples near the mouth of Caney Branch between August and October 2001 for analyses by a private certified laboratory. No single sample value exceeded the single sample criterion, and no geometric mean value exceeded the applicable geometric mean criterion. Thus, ADEM removed this segment of Caney Branch from the 303(d) list in 2002.

Partners and Funding

ADEM provided $450,000 in section 319 funds to support a watershed coordinator, BMP installation, and water quality monitoring in the Weeks Bay Watershed. The Gulf of Mexico Program, through the Baldwin County Soil & Water Conservation District, provided $157,600, and landowners provided $113,600 in matching funds for a total project cost of $720,000. Partners involved in implementing the Weeks Bay and Weeks Bay National Estuarine Research Reserve Management Plans include Alabama Department of Conservation and Natural Resources, the Weeks Bay Reserve Foundation, the Baldwin County Department of Public Health, the U.S. Fish and Wildlife Service, the Dauphin Island Sea Lab, the University of South Alabama, the Alabama Clean Water Partnership, businesses, and local citizens.

Table 2. ADEM final monitoring results (Site CNYB-1)

Date (2001)	Fecal Coliform (# col/100 mL)	Geometric Mean (# col/100 mL)
April 25	48	101
May 01	100	
May 02	140	
May 09	120	
May 16	130	
Oct 09	70	56
Oct 17	110	
Oct 24	56	
Oct 31	38	
Nov 05	34	

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Section 319 NONPOINT SOURCE PROGRAM SUCCESS STORY

Alabama

Best Management Practices, Public Outreach Help River Recover from Impairments

Waterbody Improved Runoff from agricultural activities and urbanization contributed to organic enrichment and dissolved oxygen (DO) impairments in the lower mainstem of the Flint River in Alabama. The implementation of best management practices (BMPs) and stakeholder education and outreach enhanced water quality and helped the Flint River meet the water quality standards associated with its designated water use classifications. As a result, the Alabama Department of Environmental Management (ADEM) expects to remove a 28-mile segment of the Flint River from the state's 2006 303(d) list of impaired waters.

Problem

Originating in Tennessee, the Flint River flows south through Madison County, Alabama, before joining the Tennessee River. Data collected during the mid-1990s revealed that a 28-mile segment of the Flint River was not meeting its designated water use classifications as a public water supply and fish and wildlife resource. Consequently, the segment was placed on Alabama's 1998 303(d) list of impaired waters for organic enrichment and low dissolved oxygen.

ADEM variously listed the sources of water quality impairments as unknown in 1998, agriculture in 2002, and agriculture/urban runoff in 2004.

Exclusion fencing was installed to limit cattle's access to creeks, and alternative watering sources were constructed at eight different locations.

Project Highlights

ADEM used a section 319 grant to reduce the cumulative effects of nonpoint source pollution. Between 2001 and 2003, federal, state, and local agencies teamed with local landowners to implement numerous agricultural BMPs, including

- winter cover and conservation tillage on 2,000 acres
- livestock BMPs (e.g., stream crossings, alternative watering facilities, exclusion fencing, rotational grazing plans) on 10 farms encompassing 400 acres
- cropland conversion of 10 acres
- heavy-use protection areas on 13 sites
- annual soil tests and nutrient management plans covering 300 acres

Partners also led numerous education and outreach activities, including stream cleanups, presentations at local schools, landowner/public meetings, and field days. The local news media's coverage helped outreach efforts.

Volunteers who live, work, and recreate in the area supported stream cleanup efforts throughout the watershed.

Results

Between March and October of both 2003 and 2005, ADEM collected dissolved oxygen data at three sites on the impaired segment of the Flint River. The agency also collected continuous dissolved oxygen data at two of the sites during July 2005.

As shown in the following table, only two monthly measurements (4.6 mg/L and 4.97 mg/L) fell below the state minimum criterion of 5.0 mg/L for the public water supply and fish and wildlife designated water use classifications. Furthermore, none of the continuous

Station	Type of data	# of samples	DO < 5 mg/L
FLIM-5	Water column	17	0
FLIM-6	Water column	17	1
	Continuous	217	0
FLIM-7	Water column	17	1
	Continuous	216	0

Project leaders measured water column dissolved oxygen concentrations at three stations during separate 8-month periods in 2003 and 2005. In addition, continuous dissolved oxygen monitoring occurred at two stations in July 2005. Only two water column samples showed concentrations below the water quality standard of 5 mg/L.

dissolved oxygen measurements were below the minimum criterion.

ADEM's assessment methodology stipulates that conventional water quality parameters, including dissolved oxygen, may not exceed water quality standards more than 10 percent of the time in waterbodies designated as public water supply and fish and wildlife resources. The data demonstrate that this 28-mile segment of the river now meets this requirement. As a result, ADEM has proposed that the segment be removed from the state's 2006 303(d) list of impaired waters. The next scheduled monitoring year for the segment is 2008.

Partners and Funding

ADEM provided $250,000 in section 319 funding to support a watershed coordinator and to implement BMPs. Other stakeholders—including the Madison County Soil and Water Conservation District, the U.S. Department of Agriculture–Natural Resources Conservation Service, the Tennessee Valley Authority, the Flint River Conservation Association, and the City of Huntsville—contributed $331,000 in nonfederal matching funds. The total project cost was $581,000.

Sediment loading in the watershed was reduced by implementing conservation tillage and planting cover crops on approximately 2,000 acres.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Arizona

Nutrioso Creek: A Nonpoint Source Success Story

Waterbody Improved

Arizona placed a segment of Nutrioso Creek on the state's Clean Water Act (CWA) Section 303(d) list of impaired waters in 1998 because of high turbidity. The impairment negatively impacted several native fish, including one federally listed species. Arizona identified streambank erosion as the cause for the turbidity. Shortly before the creek was listed as impaired, private landowner Jim Crosswhite purchased property—the EC Bar Ranch—on Nutrioso Creek. He quickly began to address water quality and habitat concerns. Crosswhite implemented best management practices (BMPs) that controlled activities of grazing animals such as livestock and elk, restored the stream channel, and reduced turbidity. In 2007, because the impaired segment of Nutrioso Creek once again met water quality standards, Arizona recommended that it be removed from the list of impaired waters.

Problem

Eastern Arizona's Nutrioso Creek, a 27-mile perennial stream in the White Mountains of Apache County, is a tributary to the Little Colorado River. Several native fish live in these waters, including the federally endangered Little Colorado spinedace (*Lepidomeda vittata*). In 1998 Arizona placed a 7-mile segment of Nutrioso Creek on the list of impaired waters because it exceeded the 10 Nephelometric Turbidity Units (NTU) standard for coldwater stream aquatic and wildlife habitat. The state identified impairments on 4 miles of creek in the Apache-Sitgreaves National Forest and along 3 miles of creek on the privately owned EC Bar Ranch. The state identified historic grazing practices as the primary cause of high turbidity levels. As grazing animals had trampled and consumed Nutrioso Creek's riparian vegetation, streambank stability decreased and streambank erosion increased over time.

Newly restored Nutrioso Creek now has a higher water table, less erosion, and more wildlife species.

Project Highlights

In 1996 Jim Crosswhite purchased the EC Bar Ranch and began to address water quality and aquatic/wildlife habitat concerns in the creek. Crosswhite followed a three-step approach to improving the riparian area. First, he implemented BMPs: (1) he fenced out elk entirely and limited livestock grazing to the dormant winter months; (2) he planted willow poles and installed practices such as weirs to reduce streambank erosion; and (3) he established native narrow-leaf cottonwoods and Western Wheatgrass. Crosswhite's second step was to adopt livestock (cattle), nutrient, irrigation water, and pest management plans recommended by the Natural Resources Conservation Service (NRCS). As his final step,

Crosswhite used fences to eliminate or control wildlife and livestock activities in the riparian areas.

he is considering long-term planning options that can protect the restored area, such as a conservation easement, deed restrictions, and/or sale of riparian areas to the U.S. Forest Service (USFS). To date no final protective action has been completed, although some agreements have been drafted, initial surveys and appraisals completed and aerial photos taken.

Crosswhite has provided public outreach through written publicity, personal presentations, and field trips. Crosswhite maintains a project Web site (www.ecbar-ranch.com) where information about BMPs, agency reports, and monitoring is available. Crosswhite's extensive outreach initiatives help to educate other landowners on many of the BMPs that they can implement in the Nutrioso Creek area and beyond.

Results

Crosswhite worked closely with the Arizona Department of Environmental Quality (ADEQ) to implement BMPs that controlled activities of large grazing animals, restored the proper functioning condition in the stream channel, and reduced turbidity levels. The condition of soils, vegetation, and hydrology was improved from non-functional in 1996 to proper functioning condition in 2005 using the Bureau of Land Management rating system. In addition, monitoring results showed that turbidity levels plummeted from more than 50 NTU in 2000 to less than 10 NTU by 2004. Nutrioso Creek once again meets water quality standards. Therefore, in 2007, the ADEQ recommended removal of Nutrioso Creek from the 303(d) list, making it the first impaired waterbody in Arizona to be delisted as a result of mitigation.

Additionally, the U.S. Fish and Wildlife Service (USFWS) was so impressed with the aquatic habitat recovery on the EC Bar Ranch's portion of Nutrioso Creek that it captured and moved 767 Little Colorado spinedace from degraded pools downstream on National Forest land to the restored habitat on the EC Bar Ranch. In a letter to Crosswhite, the USFWS emphasized that, "the practice of salvaging a listed species from public land and repatriating the species to private land is rarely warranted and demonstrates [Crosswhite's] commitment to threatened and endangered species."

Partners and Funding

Crosswhite partnered with state and federal agencies, such as the ADEQ, Arizona Game and Fish Department (AGFD), Arizona State Land Department, Arizona Department of Agriculture, Arizona Water Protection Fund, NRCS, and USFWS. He worked with many organizations to address a broad spectrum of environmental concerns, including those outlined in Nutrioso Creek TMDL for Turbidity Report (ADEQ 2000), Little Colorado River Spinedace Recovery Plan (USFWS 1998), Nutrioso Creek Fish Management Report (AGFD 2001), and the Upper Little Colorado River Watershed Based Plan (2000-2006). He was the first private landowner in Arizona to complete a Safe Harbor Agreement with the USFWS (2003)—this agreement promotes voluntary management for listed species on nonfederal property while assuring participating landowners that no additional regulatory restrictions will be imposed.

Crosswhite's Nutrioso Creek restoration project cost exceeded $2 million, a portion of which was funded by $575,000 from CWA Section 319 grants, $100,000 from NRCS, and $163,000 from wildlife agencies and others. Crosswhite matched more than 60 percent of public funding with his own resources.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Connecticut

Menu of Measures is a Recipe for Success

Waterbody Improved

Edgewood Park Pond was in danger of becoming a marsh due to its highly eutrophic condition and shallow depths. Project leaders devised a plan that included stormwater diversion, dredging, revegetation, and fish habitat restoration. These actions contributed to reduce sedimentation, improve fish habitat, and reduce fecal contamination by waterfowl. Consequently, pond water quality has improved dramatically, the pond's eutrophic state has been eliminated, and large fish have returned. Because of these results, the Connecticut Department of Environmental Protection (CT DEP) expects to partially remove the pond from the state's 303(d) list of impaired waters in 2006.

Problem

The 2.7-acre Edgewood Park Pond is northwest of downtown New Haven, Connecticut, along the shore of Long Island Sound. Over many years, a steady accumulation of organic matter reduced the pond's average depth to 2.5 feet. During summer months, the shallow waters became too warm for fish survival and algal blooms transformed the pond into a pool of green muck and unpleasant odors.

To understand the source, nature, and context of the problem, the City of New Haven undertook a diagnostic feasibility study of the pond in 2000. With a goal of restoring the pond to a warm-water fishery resource, the study included an inventory and assessment of existing pond and watershed conditions, determined factors responsible for the pond's degradation, and proposed specific actions to restore the pond. The study revealed that the pond was a nutrient-enriched, sediment-filled, shallow, highly eutrophic waterbody unsuitable for contact recreation and fishing. It also concluded that the pond was often an aesthetic and odor-emitting nuisance, low-quality fish habitat, seasonal nutrient source, and undesirable educational resource.

Several sources contributed to pond degradation. Sparsely vegetated—and hence highly erodable—land sloped toward the pond and delivered high sediment loads during storm events. Discharge from a nearby storm pipe further exacerbated bank erosion. The storm pipe, pet wastes left along the bank, and waterfowl were also suspected bacteria and nutrient sources.

Decades of organic matter accumulation reduced average pond depth to 2.5 feet, with some areas as shallow as 1.5 feet. Dredging restored the pond to a maximum depth of 10 feet.

By 2004, the pond was on the state's 303(d) list for aquatic life use impairments due to low dissolved oxygen and siltation caused by nutrients and sediments. The pond was also listed for primary contact recreation impairments due to nutrients and bacteria. The state listed the pond on the basis of observations of eutrophication and the absence of its former fishery.

Project Highlights

The City of New Haven applied for and received several section 319 grants needed to help restore the pond as a fishery and recreation resource. In 2004 and 2005, the city, CT DEP, and other conservation partners took a number of measures:

- Dredging the pond to a maximum depth of 10 feet. This removed approximately 12,500

One view of Edgewood Park Pond after restoration. Littoral plantings and a stabilized bank are shown to the center and left.

cubic yards of nutrient-rich sediments from the pond bottom.

- Redirecting the storm pipe away from the pond and into a nearby wetland, facilitating the removal of nutrients, sediments, and other nonpoint source pollutants.
- Planting littoral vegetation to reduce slope erosion and discourage geese and other waterfowl from accessing the pond.
- Improving fish habitat by installing fish structures, felled trees, and littoral zone plants.
- Using construction and vegetative planting approaches to stabilize the slope on one side of the pond.

Results

The project was an overwhelming success, with water quality improvements visibly apparent to even the casual observer. Large fish have returned, and the pond edge has been stabilized.

With the nutrient and sediment impairments resolved, CT DEP expects to remove Edgewood Pond's aquatic life use impairment from the state's 303(d) list in 2006. While nutrient loads have been reduced, the other cause of the pond's primary contact recreation impairment—bacteria—remains a problem. For this reason, the pond will remain listed for primary contact recreation. Water quality monitoring will continue beyond 2006.

Beyond the physical improvements to the pond, this project produced many other benefits. For example

- It restored the pond's status as a valuable recreational and educational resource for city residents.
- It demonstrated the benefits of urban environmental restoration projects to human and natural resources.
- It coalesced a diverse group of park and pond constituents and raised general public awareness about the need for continued stewardship of this important resource.
- It helped to enhance the quality of life for low-income residents of New Haven affected by pollution.

Since the restoration project was completed, local schools have used the pond to conduct seining activities and aquatic environment education programs, and the Edgewood Park Ranger has used it for canoeing and fishing programs. The pond has once again claimed its place as one of the most beautiful assets in Edgewood Park and the surrounding neighborhood.

Partners and Funding

With support from the federal section 319 program, CT DEP provided $267,600 for the pond study and restoration program. The City of New Haven provided more than $90,000 toward the project design and construction and contributed in-kind services for project management, landscape design, and site grading.

The city built on the success of the initial pond restoration and mobilized the Elm City Parks Conservancy, the Friends of Edgewood Park, and the Yale University Forestry School's Urban Environmental Initiative to undertake the final slope stabilization project. The city provided an additional $35,000 for a consultant to provide construction materials and oversee volunteers.

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Stabilizing Streambanks and Restoring Wetlands Improves Habitat

Waterbody Improved

Streambank modification/destabilization contributed to total suspended solids (TSS) impairment of a 6.6-mile segment of Addison Creek in Illinois. Implementing streambank stabilization techniques and wetland restoration measures through section 319 of the Clean Water Act (CWA) enhanced water quality and helped Addison Creek meet TSS water quality goals for its designated water use classifications.

Problem

Data collected in 1998 revealed that Addison Creek was not supporting designated uses for aquatic life, in part because of TSS. This data also suggested that stormwater runoff contributed to the impairment through streambank modification/destabilization. As a result, the Illinois Environmental Protection Agency (EPA) placed a 6.6-mile segment of Addison Creek in Cook County, Illinois, on the 2002 CWA section 303(d) list of impaired waters (Figure 1).

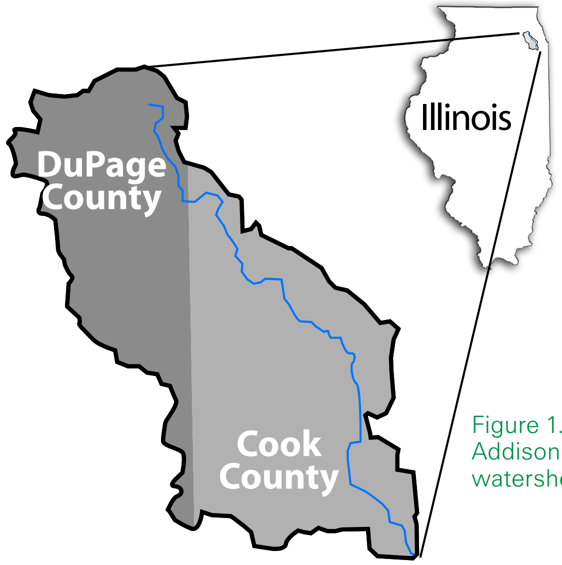

Figure 1. Map of Addison Creek watershed.

Project Highlights

Illinois EPA used CWA section 319 funds to implement three nonpoint source pollution control projects in the Addison Creek watershed since 1998. These projects reduced nonpoint source pollution by applying bioengineering techniques to stabilize approximately 8,720 feet of eroding streambanks. Specific techniques included A-jacks with vegetation, Stabilator toe with vegetation, riprap, lunkers, and vegetated gabion baskets (Figures 2 and 3). The project partners also removed selected trees to allow increased light penetration, built riffles, and planted native forbs, grasses, and sedges. In addition, they restored a 30-foot-wide, 1.29-acre wetland on each side of a 1,300-foot-long section of stream (Figure 4).

Figure 2. A gabion toe (cage filled with earth and rocks) protects the left and right banks in this section of Addison Creek.

Addison Creek is a tributary of Salt Creek, which is also included on Illinois' CWA section 303(d) list. A report containing the total maximum daily loads and the implementation plan for

Figure 3. Streambank stabilization techniques used on this portion of the creek include vegetated banks with an A-Jacks toe on the left bank and a Stabilator toe on the right bank.

Figure 4. Along this section of the creek, the partners restored a streamside wetland and stabilized the streambank with vegetation, riprap, and riffles.

Salt Creek was completed and approved in September 2004.

Results

Although Addison Creek was still identified as not supporting designated uses for aquatic life in 2006, TSS and streambank modification/destabilization have been removed as a cause and source of impairment. TSS did not exceed 116 milligrams per liter in any samples from the Ambient Water Quality Monitoring Network station on Addison Creek between 2000 and 2003. Habitat data collected in 2001 at this station rated bank vegetative protection/stability as good. The segment will remain listed for excess nutrients, various metals, pathogens, total dissolved solids, and flow regime alterations.

Partners and Funding

A combination of $444,561 in section 319 grants and $300,891 in matched costs enabled Addison Creek Conservancy District to implement streambank stabilization practices. The restoration of the riparian buffer zone was completed by the City of Northlake using $296,443 in section 319 funding and $2,000,000 local cost-share. The total cost of this project was $3,041,895.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Indiana

Agricultural BMPs Reduce Chlordane and Sediment in Pigeon Creek

Waterbody Improved Pigeon Creek, in southwestern Indiana, was impaired for chlordane and other priority pollutants from use of these chemicals on agricultural lands with poor stream buffers and high historic soil loss. Indiana placed 32 miles of this waterbody on its 303(d) list in 1996 and again in 1998 based on fish tissue data collected. Installing best management practices (BMPs) such as vegetated buffers and conservation tillage, combined with landowner education, produced a measurable improvement in water quality. As a result, Indiana removed Pigeon Creek from the 303(d) list in 2002.

Problem

The Pigeon Creek watershed lies within Posey, Warrick, Gibson, and Vanderburgh counties in southwestern Indiana. The creek flows south to the Ohio River, where its waters enter upstream of the city of Evansville's drinking water intake. Agriculture is the watershed's main land use. Crops in this watershed were historically treated with chlordane to control insects. Even though use of chlordane was prohibited in the early 1980s, high levels of this chemical persist in the sediments in Pigeon Creek and its tributaries. Because these chemicals form a strong bond with soil, Indiana Department of Environmental Management (IDEM) and local watershed groups have identified erosion from agricultural lands as the chief source of these pollutants.

The allowable threshold level of chlordane at the time that the original samples were collected would have been the U.S. Food and Drug Administration's (FDA's) action level for chlordane, which is the total of all isomers with results > 0.02 milligrams per liter. The value cited for fish tissue in the FDA's handbook, *Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed,* is 0.3 parts per million (ppm), which was current as of August 2000.

Project Highlights

In 1997 the Citizens for the Improvement of Pigeon Creek cooperated with the Natural Resources Conservation Service (NRCS) and the Vanderburgh County Soil and Water District (SWCD) to develop a watershed plan for the portion of Pigeon Creek in Vanderburgh County. The partners received Clean Water Act (CWA) section 319 funding to support projects on Pigeon Creek and its tributaries, including enhanced watershed planning, education, and installing BMPs such as filter strips, grassed waterways, field buffers, and conservation tillage.

From 1997 through 2001 the partners installed more than 50 BMPs designed to reduce soil erosion in the Pigeon Creek watershed. These land treatment measures have significantly reduced the amount of contaminant reaching the stream, allowing the legacy sources to be covered by cleaner sediments from other points in the watershed, moved naturally, or degraded over time. Locally led efforts continue to address sediment loading to streams in the Pigeon Creek watershed.

Results

In 2002 IDEM assessed water quality in Pigeon Creek to determine whether a total maximum daily load (TMDL) was still needed. IDEM further analyzed Pigeon Creek in 2005. IDEM compared the 1992 and 2005 data to the current FDA action level for chlordane (see table).

Table 1. Comparison of fish tissue chlordane isomer levels taken from channel catfish sampled in Pigeon Creek at Kleymyer Park, Evansville, Indiana. The sample point is near the lowest point of the Pigeon Creek watershed.

Parameter	September 1992 sample results (wet weight)	August 2005 sample results (wet weight)	Reduction
Chlordene, Alpha-	.082 ppm	.014 ppm	83%
Chlordene, Gamma-	.056 ppm	.004 ppm	93%
Nonachlor, cis-	.055 ppm	.009 ppm	84%
Nonachlor, trans-	.11 ppm	.032 ppm	71%
Oxychlordane	.012 ppm	.001 ppm	92%
Total chlordane residue	**.315 ppm**	**.060 ppm**	**81%**
FDA action level for chlordane*	**.3 ppm**	**.3 ppm**	–

* Maximum concentration of allowable levels of chlordane residue in edible portions of fish tissue.

Using the FDA action levels for determining impairment, the results indicated that Pigeon Creek was no longer impaired for chlordane. Therefore, the data indicated that chlordane and priority organic pollutant levels had dropped to levels sufficient to remove Pigeon Creek from the 303(d) list for both parameters.

The reductions in chlordane and other priority organic pollutants can be attributed to the efforts in this watershed to address sedimentation from erosion of croplands, which is the primary source of these pollutants. The BMPs in 1999 resulted in an estimated soil savings of 584 tons per year. Chlordane levels in fish tissue dropped significantly, including levels of chlordane breakdown isomers, further indicating that the sources of chlordane were successfully addressed by installing agricultural BMPs.

The Pigeon Creek Watershed Management Plan is addressing other water quality impairments in addition to those associated with chlordane and priority organic pollutants. IDEM and the local watershed group will continually assess progress on the status of these other impairments and determine what further work is needed.

Partners and Funding

This project was supported by $171,990 from two CWA section 319 grants (awarded in 1997 and 1999). Landowners and partner agencies within the watershed contributed an additional $42,997 in matching funds, in-kind services, and materials. Partners for the CWA section 319 grants included the Vanderburgh, Warrick, Gibson, and Posey County SWCDs, as well as the Four Rivers Resource Conservation and Development office. These partners helped to select sites for BMP installation, conduct education and outreach activities, and offer technical support. Monitoring and assessment of water quality in 2002 was funded by $78,001 from a CWA section 205(j) grant to IDEM's Assessment Branch. The Indiana Department of Natural Resources, through the Lake and River Enhancement program, funded planning and BMP installation projects amounting to $270,000 in state funds. The NRCS greatly assisted this project by allocating $135,000 each year for the years of 1997, 1998, and 1999 through the Environmental Quality Incentives Program.

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Nine Eagles Lake Overcomes Siltation and Turbidity Problems

Waterbody Improved

Even though the Nine Eagles Lake watershed lies within Nine Eagles State Park and is almost entirely forested, erosion has created siltation and turbidity problems in the lake. Sediment basins were constructed to slow sediment delivery to the lake, and trails were reworked to reduce erosion. Post-project monitoring data reveal an 85 percent reduction in sediment delivery, exceeding the 50 percent reduction goal set by the total maximum daily load (TMDL).

Problem

In 1998 Iowa included Nine Eagles Lake on the state's 303(d) list due to high turbidity. The main cause of turbidity in the lake is colloidal clays, which remain suspended for long periods. The Iowa Department of Natural Resources (IDNR) completed a forestry management plan for the state park area in February 2001. A detailed assessment of the area identified improperly maintained trails and failing sediment ponds as two of the leading causes of erosion.

Project Highlights

In 2001 EPA approved a TMDL for turbidity in the Nine Eagles Lake watershed. The TMDL established water clarity targets (as measured by a Secchi disk depth) of 1.25 meters and a 50 percent reduction in sediment delivery.

To accomplish these goals, IDNR developed an implementation plan for Nine Eagles Lake focusing on reducing sediment delivery in the watershed. Section 319 grant funds were used to construct 17 sediment basins. In 2003 the IDNR Parks Bureau rerouted and reworked some of the trails to reduce impacts. Throughout the project, care was taken to protect the forested areas, home to the endangered Indiana bat.

Nine Eagles Lake is a popular recreation area where visitors enjoy swimming, boating, and fishing.

Results

To evaluate the impact of the project, bathymetric mapping was used to map the original lake bottom and the depth of sediment deposits. Further monitoring of Nine Eagles Lake took place in 2000–2004 as part of the Iowa Lakes Survey.

Seventeen new sediment basins were constructed using section 319 funds.

After installation of the new sediment control structures, monitoring data indicated an 85 percent reduction in sediment delivery to Nine Eagles Lake, surpassing the TMDL target of a 50 percent reduction. The average Secchi disk depth increased to 1.7 meters (n=14), exceeding the TMDL target of 1.25 meters. Because the TMDL targets for sediment delivery reduction and Secchi disk depth have been met, IDNR has removed Nine Eagles Lake from the next 303(d) list of impaired waters for turbidity.

Partners and Funding

Many bureaus within the IDNR worked together throughout this project, including the Nonpoint Source Program, Forestry Bureau, Fisheries Bureau, Parks Bureau, and TMDL program. IDNR also called on the expertise of the U.S. Geological Survey to use benthic mapping to show the original lake bottom and the depth of sediment deposited in the lake. Section 319 grant funds totaling $139,689 provided the necessary funds to construct sediment basins throughout the watershed.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Iowa

Sediment Basins at Slip Bluff Lake Reduce Sediment by 85 Percent

Waterbody Improved Even though 70 percent of Slip Bluff Lake's 240-acre watershed lies within Slip Bluff Lake Park, erosion occurring throughout the watershed created a sediment problem in the lake. Sediment control basins were constructed throughout the watershed to slow sediment delivery, and the lake's shoreline was stabilized with riprap. Sediment delivery was reduced by 64 percent, exceeding the 50 percent goal set by the total maximum daily load (TMDL).

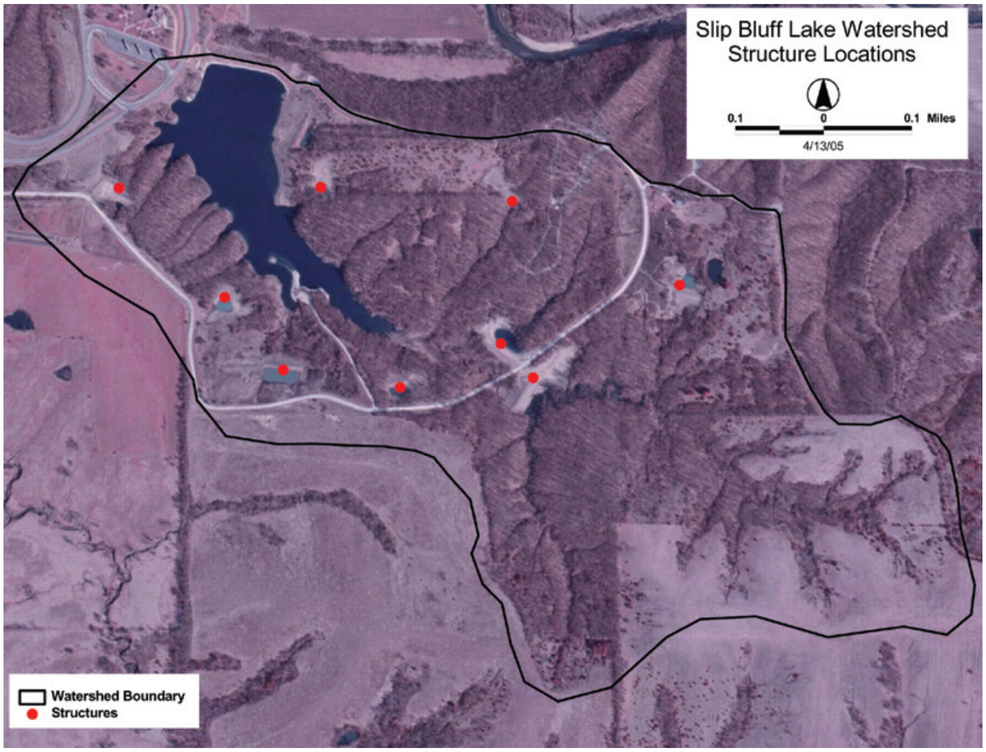
Problem

Iowa included Slip Bluff Lake on the state's 1998 303(d) list because of impairments due to siltation. The main source of sediment delivery to the lake was gully and streambank erosion in the forested areas of the watershed. This erosion contributed colloidal clays, which stay in suspension for long periods. Shoreline erosion was also contributing large amounts of sediment to the lake.

Project Highlights

In August 2001 EPA approved a TMDL for siltation that called for a 50 percent reduction in sediment delivery to the lake. To accomplish this goal, the Decatur County Conservation Board and the Decatur Soil and Water Conservation District proposed the construction of two large basins to slow sediment delivery originating from gully erosion. The Iowa Department of Natural Resources' (IDNR) Nonpoint Source Pollution Program provided further suggestions to address the problem using a watershed approach. As a result, the plan was expanded to include seven smaller sediment basins throughout the watershed. To further stabilize the shoreline of Slip Bluff Lake, the Iowa Department of Transportation and the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation (IDALS-DSC), provided funds to riprap portions of the shoreline.

Sediment basins prevent excess sediment from reaching the lake by collecting runoff water and allowing sediment to settle out of the water and be deposited in the sediment basin.



Sediment control structures were constructed throughout the watershed to reduce sediment delivery to the lake.

To ensure the continued success of this project, the Decatur County Conservation Board maintained the project by planting additional seedings in exposed soil on the constructed sediment basins.

Results

Following the installation of the sediment basins, sediment delivery to Slip Bluff Lake was recalculated. Monitoring data indicate a 64 percent reduction in sediment delivery, exceeding the 50 percent goal set by the TMDL. The sediment reduction also resulted in a 50 percent improvement in water transparency. Slip Bluff Lake is no longer listed on the Iowa 303(d) list for sediment.

Partners and Funding

IDALS-DSC Watershed Protection Program Funds totaling $35,000 covered the cost of constructing the two large sediment basins, and IDNR, through section 319, provided $31,219 for the construction of the seven smaller sediment control structures. The Decatur County Conservation Board provided additional project funding, and IDALS-DSC and the Iowa Department of Transportation provided funds for riprap of portions of the shoreline. The IDNR Fisheries Bureau helped determine the impact of the project by conducting an aquatic life assessment at Slip Bluff Lake.

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U.S. Environmental Protection Agency
Office of Water
Washington, DC

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Acid Mine Drainage Abated in Rock Creek

Waterbody Improved Acid mine drainage from coal mines had decimated aquatic life in a 4-mile stretch of Rock Creek. Best management practices (BMPs) installed in the Rock Creek watershed, including removal of coal refuse from streambank areas and treatment of creek water with limestone to increase pH, have decreased acid loading to the creek, resulting in a reclassification from full nonsupport to partial support for aquatic life and swimming on Kentucky's 303(d) list of impaired waters.

Problem

The upper portion of Rock Creek between the Kentucky-Tennessee border and the stream's juncture with White Oak Creek is designated as a wild and outstanding natural resource water. However, below the stream's juncture with White Oak Creek, acid mine drainage, from more than 40 coal mine portals and 8 coal refuse dumps, has severely affected aquatic life. In 1990 Kentucky listed Rock Creek on the 303(d) list as nonsupporting for aquatic life and swimming. A total maximum daily load for Rock Creek is under development.

Bank restoration along Rock Creek has reduced sediment loading by 500 tons per year.

Project Highlights

The Kentucky Division of Abandoned Mine Lands led the implementation of Phase 1 of the Rock Creek restoration project in spring 2000. Coal refuse that contributes to acidic conditions in runoff was removed from the banks of the creek, and open limestone channels and a modified vertical flow wetland system were installed to further neutralize acidic drainage. Water in the creek was further treated with monthly applications of limestone sand to reduce acidity.

Results

Activities to date have dramatically improved the water quality in the lower Rock Creek watershed. Acid loading into the Big South Fork of the Cumberland River from Rock Creek has decreased from a monthly average of 110 metric tons to near zero. Removing 25,000 cubic yards of coal refuse from streamside areas and revegetating the banks of Rock Creek have reduced the sediment entering the stream by 500 tons annually. Fish populations are improving in the lower Rock Creek watershed, and the number and diversity of fish species are increasing. Stations that once supported no fish are now supporting fish. Because of these improvements, Rock Creek has been reclassified from full nonsupport to partial support for aquatic life and swimming on the 2002 Kentucky 303(d) list.

Phase 2 of this project, already in the works, includes installing more alkaline-producing features in the watershed to ensure long-term results in Rock Creek. These features will reduce the need for monthly limestone dosing of the tributaries. The 4 miles of Rock Creek affected by acid mine drainage might become a viable fishery thanks to the hard work and cooperation of the many agencies involved.

Rock Creek bank before restoration.

Partners and Funding

The Rock Creek Task Force was formed in the mid-1990s with the goal of restoring the lower Rock Creek watershed. This group includes 12 state and federal agencies and conservation organizations. Under Phase 1, section 319 provided $200,000 in grant funding for the construction of open limestone beds and removal of coal refuse from the banks of the creek. Other Phase 1 funding included $280,000 from the Appalachian Clean Streams Initiative, $250,000 from a Personal Responsibility in a Desirable Environment grant from the National Oceanic and Atmospheric Administration, $160,000 from a Kentucky Abandoned Mine Land Grant, and $80,000 from the U.S. Geological Survey cost-share program.

Rock Creek bank after restoration.

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Cobbossee Lake Restored: 35 Years of Sustained Work Succeeds

Waterbody Improved

Cobbossee Lake had a long history of nuisance algae blooms that turned its once sparkling clear, trout-filled water murky green. Nonpoint source pollution in Cobbossee Lake's watershed, as well as pollution from upstream lakes, delivered excess phosphorus into the lake. Elevated phosphorus levels promoted algae blooms, which discouraged recreation, spoiled aquatic habitat, and caused the lake to not meet water quality standards. After 35 years of restoration work, including upstream alum treatments and widespread installation of best management practices (BMPs), Cobbossee Lake exhibits remarkably improved water clarity. The lake has been free of nuisance algae blooms for the past 10 years and now attains water quality standards. This impressive recovery prompted the Maine Department of Environmental Protection (DEP) to remove Cobbossee Lake from Maine's section 303(d) impaired waters list in 2006.

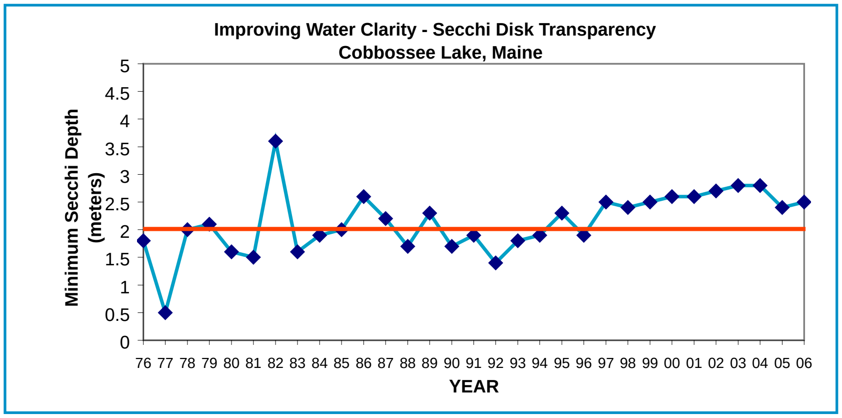
Problem

Cobbossee Lake (short for Cobbosseecontee), a large 5238-acre lake in central Maine, is valued by people for fishing, swimming, boating, and wildlife. One of Maine's premier bass fishing lakes, Cobbossee Lake is also a secondary source of drinking water for Maine's capital—Augusta.

In the 1960s water quality in Cobbossee Lake began to deteriorate. Elevated nutrient (i.e., phosphorus) levels spurred the growth of noxious blue-green algae, which reduced water clarity, formed green surface scums, and depleted oxygen in the bottom waters of the lake. The excess phosphorus in Cobbossee Lake's watershed was caused by soil erosion and runoff from agricultural, residential, and commercial lands, and the gradual conversion of forested land into developed land. The other significant source of phosphorus came from Annabessacook Lake, immediately upstream of Cobbossee. At one time, Annabessacook received sewage discharges from the town of Winthrop, and this nutrient-rich sewage caused algae blooms. Although sewage discharges to Annabessacook Lake were eliminated by 1977, the phosphorus in the lake's sediments continued to recycle and flow into Cobbossee Lake.

The Total Maximum Daily Load (TMDL) assessment developed for Cobbossee Lake in 1995 estimated that two-thirds of the external phosphorus load came from the lake's direct 32–square-mile watershed, and one-third came from the indirect upstream watershed. Agriculture accounted for about 60 percent of the phosphorus and developed lands accounted for about 40 percent of the phosphorus load. The TMDL showed that in-lake phosphorus needed to be reduced to 15 parts per billion (ppb), or 5,904 kg P/yr, for Cobbossee to attain Maine's water quality criterion for water clarity (more than 2 meters of Secchi Disc Transparency).

Governor Baldacci (left) and DEP Commissioner Littell (right) recognize cleanup of Cobbossee Lake



Minimum Secchi Depth readings (1976–2006) indicate no nuisance algal blooms have occurred since 1997. Maine's definition of a nuisance algae bloom is a minimum Secchi Disc Transparency of less than 2.0 meters in lakes.

Project Highlights

Cobbossee Watershed District (CWD), formed in 1973, collaborated with nine municipalities, Maine DEP, and federal agencies to restore Cobbossee Lake. In the 1970s and 80s, funding from EPA's Clean Lakes Program and United States Department of Agriculture's (USDA) Farm Bill Program helped farmers reduce polluted runoff on 31 dairy farms. Other farmers in this area received technical support from Maine DEP and USDA.

EPA funded two alum treatments that contributed to Cobbossee Lake's recovery. Alum forms an aluminum hydroxide precipitate that removes phosphorus from the water column and forms a long-lasting barrier on the lake bottom that substantially reduces phosphorus released from sediment. In 1978, CWD conducted an alum treatment in Annabessacook Lake. In 1986, an alum treatment and watershed BMP-implementation at another upstream lake, Cochnewagon, further reduced phosphorus inputs to Cobbossee Lake.

In addition, CWD helped towns and landowners adopt erosion control BMPs at homes, on town roads, and on private camp roads. In the early 1990s, five towns adopted ordinances requiring that new developments be designed to meet strict phosphorus allocation standards for stormwater runoff. Under two EPA section 319-funded projects in the 1990s, a significant number of erosion control and nutrient management practices were installed on dairy farms, along roads, and on residential properties. One of these section 319 projects was in Jock Stream, a major tributary responsible for one-third of the phosphorus loading from Cobbossee Lake's direct watershed.

Results

Cobbossee Lake now meets water quality standards, which in Maine means that the lake has a stable or improving trophic state and has been free of culturally induced algae blooms. Maine DEP removed Cobbossee Lake from the state's 303(d) list during the 2006 cycle.

Partners and Funding

CWD provided sustained leadership, water quality assessment, and technical services. Many local, state, and federal partners contributed funding and services over the years. Key partners include watershed towns, the Kennebec County Soil and Water Conservation District (SWCD), USDA, Maine DEP, EPA, Maine Department of Transportation, Cobbossee Lake Association, Annabessacook Lake Improvement Association, and Friends of Cobbossee Watershed.

From 1975 to 1985, EPA provided more than $1 million in Clean Lakes grants for diagnostic studies and restoration activities, including alum treatments and BMP installations, throughout the CWD. Two EPA section 319-funded projects helped control NPS in the watershed. From 1995 to 1998, CWD demonstrated effective erosion and sediment control BMPs using $35,820 in section 319 funds and $23,880 in matching funds. From 1999 to 2004, Kennebec County SWCD reduced phosphorus and sediment export from roads and farms in the Jock Stream watershed using $220,040 in section 319 funds and $152,117 in matching funds.

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Cattle Leave, Aquatic Community Returns to Furlong Creek

Waterbody Improved

Unrestricted cattle access to a 4-mile reach of Furlong Creek caused impairments to its aquatic macroinvertebrate community. With the creek unable to meet its aquatic life support designated use, Michigan placed the waterbody on its 303(d) list in 1996. Project partners installed fencing to keep cattle away from the creek. Soon thereafter, the macroinvertebrate community improved, allowing the state to delist the stream reach in 2005.

Problem

Furlong Creek flows through Mackinac County in Michigan's Upper Peninsula. Surveys conducted in 1989 found diverse fish and macroinvertebrate communities in the creek. By 1999, however, cattle grazing on private property had unrestricted access to the creek. The animals walked in the creek and trampled riparian vegetation, causing excessive instream habitat disturbance and sedimentation.

Subsequent creek monitoring revealed low fish and macroinvertebrate diversity. Pollution-sensitive insect families (e.g., caddisflies, stoneflies, and mayflies) and fish species (e.g., rainbow trout) were absent or very rare. These aquatic life support impairments led Michigan to place a 4-mile segment of Furlong Creek on its 303(d) list in 1996.

Project Highlights

In the early 2000s, the landowner, Michigan Department of Environmental Quality (DEQ), and Michigan Department of Agriculture (MDA) collaborated to address the water quality problems in Furlong Creek. MDA Right-to-Farm staff worked with the landowner to develop a farm management plan. In implementing the plan, project partners installed more than 20,000 feet of streambank fencing to exclude cattle from Furlong Creek.

Results

The accompanying table shows that, by 2004, the creek had recovered. Fish and macroinvertebrate populations were essentially identical to those found before cattle gained unrestricted access to the creek. The

Biological measurement	1989 (limited cattle access)	1999 (unrestricted cattle access)	2004 (limited cattle access)
Number of fish species	12	7	13
Rainbow trout present?	Yes	No	Yes
Kinds of macroinvertebrates	24	18	26
Kinds of mayflies	2	1	3
Kinds of caddisflies	6	0	5
Mussels present?	Yes	No	Yes
Macroinvertebrate community rating	**Attainment**	**Nonattainment**	**Attainment**

Biological monitoring data from Furlong Creek. Pollution-sensitive fish and macroinvertebrate species returned after the installation of cattle exclusion fencing.

waterbody had recovered from cattle impacts and as a result, the state removed Furlong Creek from its 303(d) list.

Partners and Funding

DEQ provided $214,000 in section 319 funds to the Luce-West Mackinaw Conservation District for streambank fencing in Furlong Creek and a neighboring watershed. The funding also supported the pre- and post-project biological surveys.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Michigan

Stabilizing Stamp Sand Deposits and Streambanks Improve Water Quality and In-stream Habitat

Waterbody Improved

Historic copper mining activities deposited mounds of fine-grained rock waste—also known as stamp sands—into the stream channels and floodplains of Kearsarge Creek and Scales Creek. Runoff from these stamp sands resulted in impaired aquatic macroinvertebrate communities and elevated water column copper concentrations, which led Michigan to list a combined segment of these waterbodies on its 2002 and 2004 303(d) list. Capping and stabilizing two large stamp sand deposits has decreased copper concentrations and improved the macroinvertebrate community enough that these impaired miles will be nominated for removal from the 2008 303(d) list.

Problem

Kearsarge Creek and Scales Creek are headwater tributaries to Houghton County's Trap Rock River in Michigan's Upper Peninsula. All three waterbodies are on Michigan's 303(d) list for excessive copper concentrations and poor biota. The 3.5-mile impaired segment of Kearsarge Creek/Scales Creek includes a portion of Kearsarge Creek upstream of where it flows into Scales Creek, as well as the lower portion of Scales Creek to its confluence with the Trap Rock River.

Copper mining operations dating from the 1860s deposited tons of fine-grained mine tailings in the floodplains of these streams, and decades of water and wind erosion have transported large quantities of these stamp sands into the stream channel and floodplain. These mineral-rich, fine-grained particles degrade aquatic life in the streams by (1) burying in-stream habitat features and (2) leaching copper into the water column. Bioassays performed in the early 1990s demonstrated that water from these headwater streams exceeded state water quality standards for copper. Biological surveys conducted at the same time found that excessive sedimentation caused degraded in-stream habitat and impoverished fish and benthic macroinvertebrate communities.

Figure 1. Kearsarge Creek before and after restoration.

Before: Stamp sand deposits cover streambanks and riparian area.

After: Removal of upstream stamp sand source allows revegetation of streambanks and riparian area.

Figure 2. Scales Creek before and after restoration.

Before: Stamp sand deposits cover streambanks and riparian area.

After: Habitat improves once stamp sand source is removed and streambanks and riparian area are stabilized.

Project Highlights

Project partners isolated two areas of stamp sand deposits from the streams by stabilizing the stream banks and capping and revegetating the upland areas. The Houghton/Keweenaw Conservation District stabilized one 2.5-acre deposit in the Kearsarge Creek watershed in 1998 (Figure 1). U.S. EPA stabilized another 19-acre deposit along Scales Creek in 2005 using Superfund Program funds (Figure 2).

Results

The Kearsarge Creek project stabilized a 2.5-acre stamp sand deposit and triggered natural revegetation downstream. This improved the in-stream habitat conditions and benthic macroinvertebrate communities. In-stream copper concentrations fell by a factor of 10, total macroinvertebrate taxa tripled, sensitive macroinvertebrate taxa (mayflies, caddisflies, and stoneflies, also known as EPT) returned, and the in-stream habitat assessment noted steadily less sediment deposition between 1991, 2001, and 2006 (Table 1). Michigan Department of Environmental Quality (MIDEQ) uses a macroinvertebrate community scoring procedure to identify impaired waterbodies. Possible scores range from -9 to +9; a score of less than -4 is considered unacceptable. Macroinvertebrate scores improved from a score of -7 in 1991 to +2 and +1 in 2001 and 2006, respectively.

The Scales Creek project stabilized 19 acres of stamp sand deposits and restored 1,205 linear feet of Scales Creek streambank. MIDEQ noted measurable improvements within one year of this project's completion; between 1991 and 2006 in-stream copper concentrations deceased slightly, total macroinvertebrate taxa increased by 40 percent, sensitive macroinvertebrate taxa doubled, and in-stream habitat features such as substrate embeddedness and sediment deposition improved substantially (Table 2). Macroinvertebrate scores, as determined by MIDEQ's scoring procedure, improved from 0 in 1991 to +4 in 2006. MIDEQ expects scores to continue to improve as biota colonizes the improved habitat. Given the positive results from both projects, MIDEQ expects to remove Kearsarge Creek/Scales Creek from the state's 303(d) list by 2008. MIDEQ will survey the creeks again in 2011.

Partners and Funding

In 1998 MIDEQ provided $44,359 in section 319 funds to the Houghton/Keweenaw Conservation District for the Kearsarge Creek restoration. EPA's Superfund Program restored the Scales Creek site in 2005 at a cost of $373,000 (including a 10 percent match from Michigan). Section 319 also funded

Table 1. Monitoring data from Kearsarge Creek, before and after stamp sand stabilization

Year	Copper (µg/L)	Macroinvertebrate taxa	EPT taxa*	Score (-9 to +9)	Habitat category	Embed-dedness	Depth regime	Sediment deposition
1991	125	3	0	-7	Fair	6	6	8
1998	*Stamp sands stabilized*							
2001	34	12	6	+2	Good	10	13	8
2005	12	12	3	+1	Good	11	14	17

*EPT= mayflies, caddisflies, and stoneflies—three orders of pollution-sensitive aquatic insects that are common in the benthic macroinvertebrate community.

Table 2. Monitoring data from Scales Creek, before and after stamp sand stabilization

Year	Copper (µg/L)	Macroinvertebrate taxa	EPT taxa	Score	Habitat category	Embed-dedness	Depth regime	Sediment deposition
1991	31	15	5	0	Poor	5	6	2
1998	*Stamp sands stabilized*							
2001	27	16	7	0	Good	8	12	8
2005	23	21	10	+4	Good	15	12	13

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Office of Water
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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Michigan

Best Management Practices Control Urban Nonpoint Source Pollution

Waterbody Improved Whetstone Brook in Michigan's Upper Peninsula was included on the 303(d) list in 1998 and 2000 for periodic fish kills. Nonpoint source pollution control projects in the watershed have led to increased habitat, restoration of the macroinvertebrate communities within the brook, and elimination of fish kills. In 2002 Michigan removed Whetstone Brook from its list of impaired waters.

Problem

Whetstone Brook flows through Marquette County into Marquette Harbor on Lake Superior, in Michigan's Upper Peninsula. Poor water quality caused fish kills in the early 1990s, which led Michigan Department of Environmental Quality (MIDEQ) to add a 1.7-mile segment of Whetstone Brook to its 303(d) list in 1998. MIDEQ attributed the problems to sediment, litter, oil, and flash flood-prone hydrologic conditions caused by uncontrolled storm water runoff from parking lots, roads, and inadequately protected upland construction sites.

Project Highlights

In the mid-1990s, the Marquette Conservation District (District) undertook a project that examined the Whetstone Brook watershed, established a watershed plan, and demonstrated best management practices (BMPs) for nonpoint source pollution management at two sites. The District installed 600 linear feet of streambank stabilization, 500 feet of a diversion outlet, 5,000 square feet of critical area stabilization, 6 acres of filter strip restoration, and a storm water detention basin. The District also conducted education efforts to highlight the brook and to reduce polluted runoff.

Results

The BMPs eliminated the cause(s) of the fish kills; the last fish kill occurred in 1994. Biological monitoring conducted in 1991 (pre-implementation) and again in 2001 (post-implementation) confirmed that the project was effective. MIDEQ uses a macroinvertebrate community scoring procedure to assess water quality. Possible scores range from -9 to +9; a score of less than -4 is considered *unacceptable*. The total number of macroinvertebrate taxa and the number of pollution-sensitive macroinvertebrate taxa (mayflies, caddisflies and stoneflies) increased after BMP implementation (Table 1). The MIDEQ macroinvertebrate score in Whetstone Brook improved slightly, from -4 in 1991 to -2 in 2001. MIDEQ removed Whetstone Brook from the 303(d) list in 2002.

Table 1. Biological data collected downstream of the Whetstone Brook project area before and after installation of BMPs

Year	Macroinvertebrate taxa	EPT taxa*	Score	Score Range -9 to +9
1991	10	2	-4	Acceptable
2001	16	4	-2	Acceptable

* EPT= mayflies, caddisflies, and stoneflies—three orders of pollution-sensitive aquatic insects that are common in the benthic macroinvertebrate community.

Partners and Funding

MIDEQ provided the Marquette Conservation District with $101,861 in section 319 funds in 1993 and $197,910 in section 319 funds in 1994. The District used these funds for both the pre-implementation planning and implementation of BMPs in this watershed.

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Washington, DC
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Lake Hazle Recovers from Development Impairments

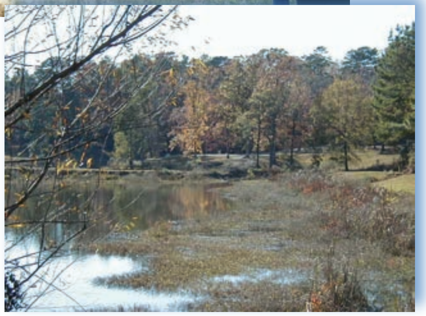
Waterbody Improved Stormwater runoff from commercial and residential development caused significant water quality impacts in Lake Hazle. The problem persisted through the 1990s, degrading the lake to the point that it only partially supported its aquatic life use support designation. Mississippi placed Lake Hazle on its 303(d) list in 1996. To address the growing problem, project partners installed various best management practices (BMPs), which allowed Lake Hazle to be delisted in 2004.

Problem

Lake Hazle is in Copiah County, south of Jackson, Mississippi. The 22-acre lake, owned and maintained by the city of Hazlehurst, is primarily designed and used for public recreation. In the 1980s, commercial and residential development around Lake Hazle led to significant impacts on its water quality.

While restoration efforts began in the early 1990s and monitoring data indicated overall water quality improvements, Lake Hazle nonetheless showed water quality impairments from nutrients, pH, siltation, organic enrichment/low dissolved oxygen (DO), thermal modification, oil and grease, and suspended solids. This information led the state to conclude that Lake Hazle only partially supported its aquatic life use support designation. As a result, Mississippi placed Lake Hazle on its 303(d) list of impaired waters in 1996. In 1998 the lake remained on the 303(d) list's *monitored section* for organic enrichment/low DO, pH, and nutrients. It was also included on the 1998 list's *evaluated section* (listed without actual monitoring data) for siltation and oil and grease.

Lake Hazle before the restoration project, almost completely filled in with silt.



Lake Hazle as it appears today, supporting aquatic life.

Project Highlights

In June 1990, project partners received section 319 support to upgrade the water quality and the recreational resources of Lake Hazle. Over a 5-year period, the partners implemented several BMPs affecting a 23-acre area. They planted vegetation at six heavily eroded sites, created a grade-stabilization structure to impede polluted runoff, and installed two water/sediment control basins to slow runoff and allow sediment to settle out before reaching the lake.

Outreach and education also played an important role. Project partners arranged to publish informative articles in the local newspaper. They also led field tours for landowners to observe firsthand the BMPs' pollutant-removal effectiveness.

Table 1. Lake Hazle water quality data from August 2001 and 2003

Date	Nitrate-nitrite (mg/L)	Total Kjeldahl nitrogen (mg/L)	Total phosphorus (mg/L)	Turbidity (NTU)	Oil & grease (mg/L)
Aug. 2001	< 0.02	0.5	0.04	11	--
Aug. 2001	< 0.02	0.5	0.05	12	--
Aug. 2001	< 0.02	0.5	0.11	10	--
Aug. 2001	< 0.02	0.5	0.04	7	--
Aug. 2003	--	--	--	4	< 5
Aug. 2003	--	--	--	--	< 5
Aug. 2003	--	--	--	6	< 5
Aug. 2003	--	--	--	4	< 5
Aug. 2003	--	--	--	11	< 5
Aug. 2003	--	--	--	7	< 5
State screening level	**< 1.0**	**< 1.5**	**< 0.2**	**< 100**	**--**

Mississippi does not have numeric water quality standards for nutrients, sediment, siltation, or turbidity. Therefore, state water quality experts compare available data for these parameters with screening levels that are based on literature or scientific *rules of thumb*. All data for these parameters were below the state screening levels and justified Lake Hazle's delisting. Mississippi has neither a numeric water quality standard nor a screening level for oil and grease. Best professional judgment determined that oil and grease concentrations less than 5 mg/L meet the applicable state narrative water quality standard.

Table 2. Average Lake Hazle dissolved oxygen concentrations in 2003 and 2004

24-Hour sampling period	Type of data	Number of samples	Average DO (mg/L)
08/07/03–08/08/03	automatic data sonde logging at 30-minute intervals	58	6.6
08/14/03–08/15/03		56	5.0
06/10/04–06/11/04		96	7.3

The aquatic life criterion for dissolved oxygen is > 4 mg/L (under specific sampling conditions and frequency).

Results

Lake Hazle began to show the beneficial effects of the BMPs after several years of vegetative growth and sediment retention. Their implementation resulted in an estimated soil savings of about 2,240 tons per year. Water quality studies gave additional quantitative evidence of the restoration's success. Studies in 2001 and 2003, for example, showed that nutrient, turbidity, and oil and grease concentrations in Lake Hazle were within acceptable water quality screening levels. In addition, DO data collected during three separate 24-hour monitoring events in 2003 and 2004 met water quality standards. Tables 1 and 2 summarize these findings.

On the basis of the monitoring results, nutrients, turbidity, organic enrichment, low DO, and oil and grease were eliminated as causes of impairment. Lake Hazle once again fully attained its aquatic life use support designation and was delisted in 2004.

Partners and Funding

This project was supported by $45,641 in section 319 funds. The Mississippi Soil and Water Conservation Commission (MSWCC) and participating landowners contributed an additional $47,168 in matching funds, in-kind services, and materials. MSWCC led in the selection and installation of BMPs. The local Soil and Water Conservation District, the city of Hazlehurst, and the Southwest Mississippi Resource Conservation and Development District oversaw public outreach efforts. Other partners included the Copiah County Soil and Water Conservation District, U.S. Environmental Protection Agency, Mississippi Department of Environmental Quality, and USDA Natural Resources Conservation Service.

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Agricultural BMPs Reduce Herbicide Concentrations in Five Drinking Water Lakes Cameron Lakes, Mark Twain Lake, and Smithville Lake, Missouri

Waterbody Improved

Herbicide application to row crop agriculture and subsequent storm runoff impaired the water quality of five lakes in northern Missouri that were used as sources of drinking water. In 1998 the three Cameron Lakes, Mark Twain Lake, and Smithville Lake were placed on the 303(d) list of impaired waters for periodic high-atrazine concentrations. The project partners used a science-based approach to identify priority watersheds with the highest pollutant loading contributions. Through an outreach program, farmers were encouraged to measure and time atrazine applications more carefully, which allowed all five lakes to successfully meet water quality standards and to be removed from the 303(d) list in 2003.

Problem

In 1998 the Missouri Department of Natural Resources placed five lakes in northern Missouri (three Cameron Lakes, Mark Twain Lake and Smithville Lake) on the 303(d) list because they exceeded state water quality standards for atrazine. All had periodic atrazine concentrations above the Maximum Contaminant Level (MCL) of 3 parts per billion (ppb) established for public drinking water supplies.

Atrazine is a low-cost herbicide used for combating grass and broadleaf weeds in corn and is widely used. Farmers were concerned that they would have to greatly restrict use of the herbicide in their corn and soybean operations. The Environmental Resources Coalition (ERC), a nonprofit organization, used 319 funding and, with partners, formed the Watershed Research, Assessment and Stewardship Project (WRASP) to put together a strategy to improve water quality without negatively affecting farmers' business profits.

Project Highlights

Monitoring was conducted from 1999 through 2004 to evaluate the origin and quality of the water running into the affected lakes.

Lake monitoring was conducted before and throughout the growing season.

Approximately 50 automatic monitoring samplers were placed at field edges and in large and small streams that flowed into the lakes. Strategically sited monitoring stations measured the relative contribution of smaller subwatersheds into the lakes. Stream flow was taken into account at each sampling location. Each station had instrumentation that allowed simultaneous sampling and flow measurements during peak rainstorm flow events. The lakes themselves were sampled in late March (before seasonal atrazine applications) and continued every 3 weeks until September. The

Edge-of-field runoff monitoring equipment

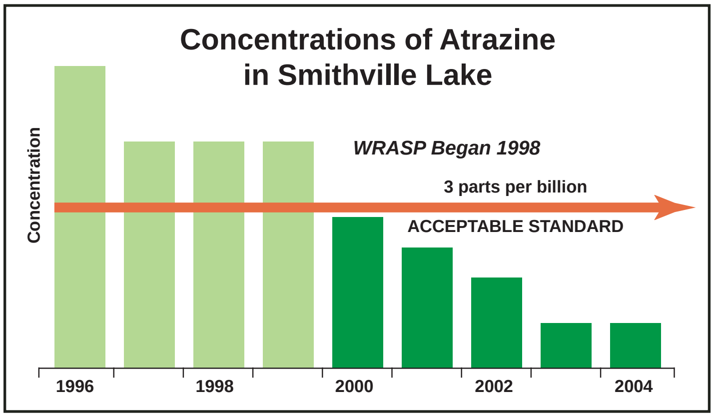
resulting data identified subbasins that contributed disproportionately to pollutant loads into the lakes.

Farmers were encouraged to voluntarily install best management practices (BMPs) to cost-effectively reduce pollutant runoff. Two tillage practices—no-till and minimum-till—were combined with selected atrazine application methods. Atrazine was applied at one of two rates—0.75 lb/acre or 1.5–2 lb/acre—using one of three methods: incorporation into the soil before planting, surface application before planting, or surface application after crop emergence. Grass buffer strips were also planted to retard and capture field runoff before it entered waterways. To promote these voluntary farmer practices, WRASP conducted field demonstrations, informational meetings, and one-on-one consultations with farmers from 2002 to 2004.

The Missouri House Interim Committee on Water Quality visit a WRASP site.

Results

Levels of atrazine (and other contaminants in the lakes) began to decrease after the first year of the project. The lakes' average levels of atrazine dropped below the MCL of 3 ppb for drinking water, and the Missouri Department of Natural Resources removed the lakes from the 303(d) list in late 2003.



Collaboration under the WRASP project led to reduced concentrations of herbicide in Smithville Lake.

Partners and Funding

ERC managed the WRASP project and administered the 319 funding. They formed a partnership with the Missouri Corn Growers Association who put together an alliance of business and governmental organizations including the Missouri Department of Natural Resources, U.S. Department of Agriculture—Agricultural Research Service, Environmental Protection Agency, Syngenta Crop Protection, Inc., and Bayer Crop Sciences. Funding for the 319 portion of the project was $1,000,000, while the total project cost was $5,000,000 over 5 years. To ensure future longevity of protective water quality practices, an ongoing Stewardship Implementation Project has been put in place. It continues the water-monitoring component of WRASP and extensively expands the one-on-one work with farmers to implement BMPs on larger, field-scale sites in the watersheds.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Missouri

Stream Restoration Efforts on Upper Cedar Creek Reduce Impacts of Acid Mine Drainage

Waterbody Improved

Acid mine drainage (AMD) from historical mining sites has degraded water quality in Cedar Creek in central Missouri for years. Even though the mines were closed and reclamation projects were completed on 704 acres of watershed land, approximately 4 miles of Upper Cedar Creek continued to suffer from AMD and remained on the state's 303(d) list of impaired waters due to high sulfates and low pH. After streambank restoration projects and the construction of passive treatment wetlands, the creek was removed from the state's 303(d) list and now meets water quality standards for both pH and sulfates.

Problem

Prior to 1977 and the passage of the Surface Mining Control and Reclamation Act, coal strip mining operations disturbed nearly 2,000 acres of the Cedar Creek watershed. AMD, generated as runoff drained over pyrite-rich soil exposed during the mining process, severely degraded water quality in the creek. Between 1948 and 1980 periodic discharges of AMD and acidic sediments into the creek resulted in numerous fish kills.

By 1990 the Missouri Land Reclamation Program (LRP) had completed reclamation projects on 704 acres of land in the Cedar Creek watershed. The reclamation projects revegetated and stabilized large areas of the Upper Cedar Creek watershed. However, a few remaining areas of barren acidic spoil and eroding streambanks continued to contribute acidic sediments and AMD to the Upper Cedar Creek watershed. Flooding in the 1990s further contributed to AMD problems by damaging significant portions of streambanks, causing additional acid-forming materials to be exposed and more sediment to enter the creek. Although water quality greatly improved in the 1990s, approximately 4 miles of the creek remained on the state's 303(d) list of impaired waters due to high sulfates and low pH.

Acidity, sulfates, and metals are removed from AMD as it flows through layers of limestone rock and compost in the passive treatment wetland cells.

Project Highlights

The Missouri LRP used section 319 funding in coordination with funding from the U.S. Office of Surface Mining (OSM) Abandoned Mine Land Clean Streams Initiative to complete the cooperative reclamation project to address the remaining water quality problems at Cedar Creek. In 2001 to 2002, six passive treatment wetlands and alkaline-producing cells were constructed to treat AMD by adding alkalinity and removing dissolved metals and sulfates, and four acid ponds were amended and

Native trees and grasses are thriving along sections of restored streambank.

neutralized. Streambank restoration projects further added to the health and renewal of the creek. Project partners planted approximately 200,000 native trees and shrubs and helped repair 2,700 linear feet of eroding streambank at 16 restoration sites. Sixty-six acres were amended and seeded with native grasses for erosion control and wildlife habitat enhancement. Additional native grass plantings are planned for the coming years.

Results

Data collected over the course of the 4-year restoration project indicate Cedar Creek is now meeting water quality standards for both pH and sulfates. Dissolved oxygen concentrations have also improved over time, and fewer occurrences of dissolved oxygen below 5 mg/L occurred in 2001 and 2002. Alkalinity showed the greatest increase at sites downstream of the restoration site, suggesting that the constructed wetlands are neutralizing the acid seeps. Native trees and grasses are thriving, and wildlife are returning to the restoration site and downstream areas. As a result of the successful cooperative reclamation project, the creek has been removed from the state's 303(d) list of impaired waters.

Partners and Funding

Project partners included Missouri Department of Natural Resources Water Protection Program (WPP), Boone County Soil and Water Conservation District, OSM, U.S. Department of Agriculture Natural Resources Conservation Service, U.S. Geological Survey, Missouri Department of Conservation, U.S. Environmental Protection Agency, the Columbia Audubon Society, and private landowners. Construction costs of the restoration project totaled $354,094. The LRP received $150,000 in section 319 grant funds from the WPP and $204,094 from the OSM Abandoned Mine Land Clean Streams Initiative to fund the construction of six wetland cells and restoration of streambank areas.

Maupin Road Bridge Sample Site

	pH (s.u.)	Alkalinity (meq $CaCO_3$/L)	Acidity (meq $CaCO_3$/L)
Before Project	5.7	24.3	17.8
After Project	6.8	75.8	-57.4

U.S. Environmental Protection Agency
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Successful Collaboration and Agricultural BMPs Improved 80 Miles of Sun River

Waterbody Improved The mainstem of the Sun River is split into upper and lower segments for management purposes. The Upper Sun River was listed as impaired on Montana's 2000 and 2002 303(d) list of impaired waterbodies because of excess nutrients. Landowners; local watershed organizations; and many federal, state, and local government agencies collaborated to implement agricultural best management practices (BMPs) in the Upper Sun River and its tributaries. Water quality improved as a result, allowing the Montana Department of Environmental Quality to remove the Upper Sun River from the 303(d) list for nutrients in 2006. The Sun River watershed project is a classic example of using the watershed approach to address nonpoint source pollution.

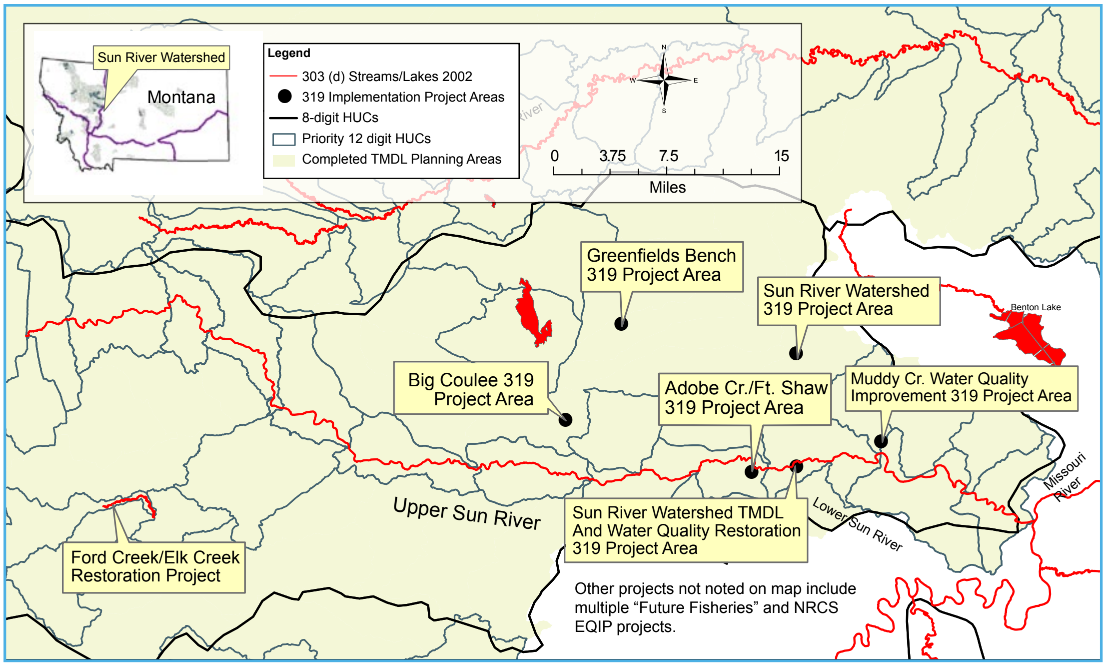
Problem

The Upper Sun River is in central Montana on the Rocky Mountain Front. The previously impaired segment is approximately 80 miles long and runs from Gibson Dam to Muddy Creek. The Montana Department of Environmental Quality (MDEQ) added the Upper Sun River to the 2000 and 2002 303(d) impaired waters list because high levels of nutrients caused the river to not meet state water quality standards for aquatic life and cold water fishery uses. Montana's nutrient standard prohibits "conditions [that] produce undesirable aquatic life," which, in this case, refers to excess growth of benthic algae that interferes with aquatic life uses. Agricultural practices were largely to blame for the Upper Sun River's elevated nutrient levels. Irrigation and stormwater runoff carried excess nutrients from over-fertilized fields and poorly managed livestock production areas into the river.

Project Highlights

Early community-planning efforts produced initial watershed plans that identified key action items for restoration. This led to the development of the *TMDL/Watershed Restoration Plan*, coordinated by MDEQ in partnership with the Sun River Watershed Group. As part of this plan, Montana set nutrient targets (39 micrograms per liter [μg/L] total phosphorus and 350 μg/L total nitrogen) for the Upper Sun River. If nutrient concentrations could be reduced to below the stated targets, excess growth of benthic algae would not occur under typical conditions. The plan also included restoration strategies for the impaired segments in the watershed.

Responding to the plan, partners have helped implement numerous water quality improvement projects in the Upper Sun River watershed. Farmers implemented nutrient management BMPs in the Ford/Elk Creek and Adobe Creek watersheds to minimize fertilizer applications and thus reduce the amount of nutrients transported to streams via runoff. Farmers improved irrigation water management practices by (1) lining irrigation canals to minimize and stabilize irrigation return flows and (2) using AgriMet—a U.S. Bureau of Reclamation satellite-based network of automated agricultural weather stations that provides weather, crop-water use, and other information to help support irrigation and agriculture management (for more information, see www.usbr.gov/pn/agrimet). In addition, landowners implemented riparian area grazing management BMPs such as fencing, stream bank stabilization techniques, and fishery improvement projects in the Ford/Elk Creek and Adobe Creek watersheds and along Willow Creek, Big Coulee, and the mainstem



Map of Sun River Watershed Restoration and Water Quality Improvements.

of the Sun River. Streambank stabilization included using non-riprap techniques such as sloping banks; planting vegetation; and installing erosion matting, root wads, and rock barbs.

Results

The cumulative effects of these on-the-ground efforts, combined with outreach and education activities that have led to better land-use practices by landowners, resulted in 20 miles of stabilized streambank, four miles of restored primary fishery and spawning habitat, 800 feet of lined irrigation canal, and the implementation of grazing management practices on 50,000 acres of rangeland. In 2005 and 2006, MDEQ collected water quality samples from the Upper Sun River. They indicated that phosphorus and nitrogen concentrations had dropped and were consistently below target levels of 39 μg/L and 350 μg/L, respectively, as identified in the *TMDL/Water Quality Restoration Plan*. As a result, MDEQ removed the 80-mile long impaired segment of the Upper Sun River from the 303(d) list for nutrients in 2006.

Partners and Funding

Many partners were involved with this project, including seven federal agencies, eight state agencies, ten local governments, four community groups, and many landowners. From 1994 to 2006, MDEQ administered $623,430 of Clean Water Act section 319 grant funding for implementing the variety of BMPs previously mentioned. In addition, $2,484,926 of nonfederal and another $1,988,793 in federal funds were used to restore the Sun River watershed through programs such as Montana's Future Fisheries program, and the Natural Resources Conservation Service's (NRCS's) EQIP program. The Fort Shaw Irrigation District, Greenfields Irrigation District, Nilan, and Sun River Ditch Company worked together to improve irrigation efficiencies in the watershed by 10 percent. The NRCS Conservation Reserve Program helped to reduce salinity by converting dry cropping lands to rangeland. The U.S. Fish and Wildlife Service; the Lewis & Clark Conservation District; and the Montana Department of Fish, Wildlife, and Parks are working on the Hogan irrigation diversion to improve fish passage.

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Innovative System Clears Up Sediment Problem in Nebraska Lake

Waterbody Improved Valentine Mill Pond was a popular destination for fishing and swimming from the turn of the century until the 1970s, when sediment problems made it impossible to enjoy the lake as before. Mechanical dredging deepened the lake and a sediment bypass system was designed and constructed to eliminate future sediment buildup. The sediment bypass system has effectively addressed the sedimentation problem, and the pond was removed from the state's 303(d) list in 2003.

Problem

Valentine Mill Pond was originally created in the 1890s by S.F. Gilman to power a gristmill. Since the 1970s the lake had shrunk from more than 30 acres to less than 15 acres. Exposed mud bars indicated the source of the problem—excessive sediment. A diagnostic feasibility study conducted by the Middle Niobrara Natural Resources District (NRD) indicated that the primary water quality concern was the amount of sand being deposited in the pond. Minnechaduza Creek, the pond's water source, was depositing as much as 60 tons of sediment into the lake daily. As a result of the feasibility study, Valentine Mill Pond was added to the Nebraska Department of Environmental Quality's (DEQ) section 303(d) list for impairment to aquatic life due to excessive sediment.

As part of the project, a unique labyrinth spillway was constructed to pass large storm event flows without manual operation. The hydrosuction system passes around the dam shown here.

Project Highlights

Mechanical dredging was necessary to remove sediment deposits and deepen the lake, but that alone would not solve the excessive sedimentation problems. To prevent excessive sedimentation from reoccurring, an innovative solution was needed. Rollin Hotchkiss, Ph.D., director of the Albrook Hydraulics Lab at Washington State University, joined the project team as a special consultant to Olsson Environmental Services. Dr. Hotchkiss, formerly with the University of Nebraska, had conducted research involving sediment bypass systems. To address the unique problems of Valentine Mill Pond, he designed a "hydrosuction sediment removal system" with a unique labyrinth spillway.

The system is designed to capture sediment as it enters the pond and to transport it via a pipeline around the dam to be discharged back into Minnechaduza Creek, without the use of external energy. "The system was also designed with the capability of collecting, through hydrosuction dredging, the sediment that was not captured by the bypass system," said Daryoush Razavian of Olsson Environmental Services. "We believe that the sediment removal system implemented at the mill pond is the first system operating in the world capable of both bypassing and dredging sediment."

Pre- and Post-Project Summer Conditions for Valentine Mill Pond

Parameter	Number of Samples	Pre-Project Median 1997–1999[a]	Number of Samples	Post-Project Median 2003[a]	% Change
Conservation pool storage	NA	76 acre-feet	NA	162 acre-feet	+ 113%
Total phosphorus	13	0.13 mg/L	4	0.07 mg/L	-46%
Dissolved orthophosphorus	14	0.05 mg/L	5	0.02 mg/L	-60%
Total suspended solids	14	31.0 mg/L	5	6.5 mg/L	-79%
Water clarity	9	21 inches	5	57 inches	+ 170%
Algae density	10	5.38 mg/m^3	4	7.51 mg/m^3	+ 40%
Nitrate nitrogen	14	0.45 mg/L	5	0.21 mg/L	-54%

[a] Median not applicable to pool storage.

Results

The sediment removal system has effectively addressed the problem of excess sedimentation in Valentine Mill Pond. Ongoing monitoring, conducted by the Nebraska DEQ, has revealed significant water quality improvements, including reductions in phosphorus, nitrates, and total suspended solids. As a result of water quality improvements, Valentine Mill Pond was removed from the state's section 303(d) list in 2003. It now supports aquatic life, serves as an agricultural water supply, and offers aesthetic enjoyment.

The hydrosuction sediment removal system lies directly beneath the walkbridge shown here.

Partners and Funding

The Nebraska DEQ provided the initial funding for the NRD's diagnostic feasibility study. However, the project would not have been possible without the cooperation of the City of Valentine, Nebraska Public Power District, Cherry County, Nebraska Game and Parks Commission, Nebraska Environmental Trust, and Valentine Mill Pond landowners. The project cost a total of $1.6 million, including $155,000 of Clean Water Act section 319 funding.

Valentine Mill Pond has been transformed from a mud hole to a popular recreation area.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Nevada

Best Management Practices Drastically Reduce Sediment and Restore Water Quality in Las Vegas Wash

Waterbody Improved The Las Vegas Wash drains the 1,600-square-mile Las Vegas Valley, delivering stormwater, urban runoff, and highly treated effluent to Lake Mead, the nation's largest manmade reservoir and the primary water supply for millions of people in Nevada, Arizona, and southern California. These sources caused water quality impairments to the lower wash due to excess sediment and iron transported with that sediment. In 2002, Nevada placed the lower reach of Las Vegas Wash on its 303(d) list of impaired waters, with impairments to aquatic life propagation (excluding fish) due to total suspended solids (TSS). Following the construction of erosion control structures, restoration of wetland areas, and removal of invasive species, average TSS concentrations declined significantly. This allowed the state to remove the lower reach from its 303(d) list in 2004.

Problem

During the past 30 years, the Las Vegas area of southern Nevada experienced dramatic population increases. Indeed, the 1,600-square-mile metropolitan Las Vegas Valley is one of the fastest growing areas in the United States. The valley drains into Las Vegas Wash, which carries stormwater runoff and wastewater 12 miles to Las Vegas Bay, an arm of Lake Mead.

Rising population and development rates have increased the volume of water discharged into the wash. An increase in impervious surfaces allows more stormwater runoff to flow directly into the wash rather than be absorbed by the soil. In addition, the growing population produces a high volume of wastewater that is discharged into the wash. The increased water flow, when added to an area already prone to flash flooding, accelerated erosion in the wash, destabilized the stream channel, significantly degraded wetland areas, and contributed excessive sediment to Las Vegas Bay.

For state water quality management purposes, Nevada divides the wash downstream of the city of Las Vegas into two reaches. The lower reach, which extends 5.12 miles upstream from

Weirs are low dams designed to reduce streambed erosion by flattening the slope of the channel and slowing flows. Many weirs are constructed of confined rock riprap, providing a somewhat natural look (top). Other structures are built with concrete, resulting in a more engineered look (bottom). Weirs, wetland restoration, and invasive vegetation removal helped reduce TSS concentrations in lower Las Vegas Wash and led to its removal from the Nevada 303(d) list in 2004.

Las Vegas Bay, has a state TSS water quality standard of 135 mg/L to protect aquatic life propagation (excluding fish). For a waterbody to be deemed in compliance with the standard, it must not exceed the standard more than 10 percent of the time over 5 consecutive years. Between 1997 and 2001, the lower reach failed to meet the 5-year exceedence criterion, so the Nevada Division of Environmental Protection (NV DEP) placed the lower reach on the 2002 state 303(d) list for impairments to aquatic life propagation (excluding fish) due to TSS.

Project Highlights

When NV DEP first listed the lower reach in 2002, efforts were already underway to restore the lower reach and protect the waterbody. In 1998 the Las Vegas Wash Coordination Committee (LVWCC) met to develop a practical, comprehensive plan to rehabilitate and manage the wash downstream of the city of Las Vegas. The Las Vegas Wash Comprehensive Adaptive Management Plan (CAMP) was approved and adopted in January 2000.

The CAMP identified various activities needed to improve water quality, such as installing weirs and other erosion control structures, creating and restoring wetlands, and controlling noxious and invasive plant species. The CAMP also called for an extensive revegetation effort to stabilize soils and replace previously lost riparian and wetland habitat.

LVWCC sponsored numerous planting events that helped increase citizen awareness and foster community support for the restoration effort. Citizen volunteers removed trash from the wash and planted wetland, riparian, and upland plant species. They also removed invasive vegetation such as tall whitetop, which has narrow and easily broken roots that destabilize the soil and allow increased bank erosion.

LVWCC initiated an extensive long-term monitoring program to provide baseline water quality data and measure the success of erosion control and revegetation efforts.

Results

As of June 2006, the project has involved constructing nine weirs, stabilizing more than 21,000 linear feet of streambank, restoring 33 acres of wetlands, and removing 500,000 pounds of trash and 680 acres of tall whitetop.

While project water quality benefits had begun to be realized before 2002, the lower reach of the wash did not meet the 5-year threshold criteria for TSS and was therefore placed on the 2002 Nevada 303(d) list. Water quality improvements continued, however, with average TSS concentrations declining 50 percent since 2001. Analysis of 1999–2003 water quality data showed that TSS concentrations exceeded the 135 mg/L standard 11 times out of 130 samples collected. This represented an 8.5 percent noncompliance rate, below the maximum 10 percent allowable rate.

With TSS data showing compliance with water quality standards, Nevada removed the lower reach's aquatic life propagation (excluding fish) impairment from its 303(d) list in 2004. The NV DEP will continue to review monitoring data to confirm continued compliance with water quality standards.

Partners and Funding

The cooperation of 28 members of the LVWCC, representing local, state, and federal agencies, local environmental groups, businesses, and interested citizens, was essential in the creation of a comprehensive management plan for the Las Vegas Wash. Volunteers also played an important role in the project, providing the needed labor for wetland and riparian plantings and invasive species removal. The overall cost to implement the CAMP is projected to be approximately $127 million through 2013.

As of 2006, $33 million has been spent on CAMP implementation. Approximately $600,000 of section 319 funds was used to support construction of erosion control structures, bank revegetation, and public outreach efforts. Participating agencies contributed $1.8 million during the 2005–2006 fiscal year.

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Project Improves Water Quality and Saves Eroding Farmland

Waterbody Improved Past removal of woody riparian shrubs made the banks of Bog Brook susceptible to erosion. As erosion continued over time, the stream channel became wider and more unstable. This made the erosion problem worse, sending tons of sediment into the stream. Project partners returned the stream channel to a more natural state and planted vegetation at the site. As a result, the channel stabilized and erosion subsided. In 2006, New Hampshire will upgrade the stream from *Impaired* by *other flow regime alterations* to *Fully Supporting* in its 305(b) surface water quality report.

Problem

Bog Brook is in the Connecticut River Basin, near the town of Stratford in northern New Hampshire. Much of the area is in agricultural use. Decades ago, riparian vegetation was removed along the streambank, presumably to increase the amount of arable land. The absence of deep-rooted shrubs made the bank vulnerable to erosion. The once meandering stream channel became marked by a sharper bend as the bank eroded. This change in stream channel geometry caused erosion to accelerate even further. The eroding stream channel eventually threatened a barn and septic system on private property, prompting a need for action.

Analysis of aerial photographs showed that the stream channel had eroded laterally up to 35 feet between 1999 and 2003, consuming 4,000-square feet of land. This translated to 120 tons of sediment—approximately the amount needed to fill 9 dump trucks—entering the stream each year to worsen water quality and smother fish habitat. Had this been allowed to continue, the stream likely would have cut a new channel into valuable farmland, sending several thousand tons of additional sediment downstream.

In 2004, New Hampshire listed Bog Brook as *Impaired* by *other flow regime alterations* in its 305(b) report with a probable source of *streambank modifications/destabilization*.

Bog Brook before restoration. Removing riparian vegetation facilitated channel erosion, which ultimately threatened the barn.

Project Highlights

The landowner adjacent to the eroding channel worked with the town of Stratford and a consultant to secure a section 319 grant from the New Hampshire Department of Environmental Services (NH DES). The project called for a comprehensive stream morphology assessment, design plan, and reconstruction of a 275-foot stretch of the stream to a more natural condition.

The partners developed the project using natural stream channel design methods. In the past, landowners and engineers typically turned to hard bank armoring for streambank erosion problems. Because armoring treats only a symptom rather than the cause of bank

Bog Brook after restoration. The project saved the barn and stopped several thousand tons of sediment from smothering fish habitat.

erosion, it is often ineffective over the long term. Natural stream channel design uses a stable reference stream to determine the proper slope, width, depth, and geometry needed to restore the impaired stream. To restore channel stability in Bog Brook, project leaders determined it necessary to

- Increase the meander radius, or curvature of the bend in the stream, to reduce stress on the eroding bank
- Increase the channel slope to improve the stream's ability to transport sediment
- Plant a vegetated buffer of deep-rooted shrubs along the streambank to help hold sediments in place

Construction occurred in May 2004. Using an excavator, a small bulldozer, and several dump trucks, project leaders realigned the stream channel, filled in the former channel, and planted riparian vegetation along the streambank.

Results

Post-construction monitoring the following year confirmed that the work had stabilized the stream system. The table below compares the reference stream with Bog Brook, before and after construction, using the three major factors determining Bog Brook channel stability. The table shows that Bog Brook, after construction, more closely matched the stable reference stream conditions.

One year after construction, the relocated stream reach had become more narrow and deeper—a positive trend indicative of channel stability. The vegetation along the bank was found to be well-established and firmly rooted.

On the basis of these post-construction findings, the state concluded that severe bank erosion had been arrested, and the sediment load to the stream had been significantly reduced. These conclusions allowed the state to upgrade Bog Brook to *Fully Supporting* in its 2006 305(b) report.

Partners and Funding

The Bog Brook restoration effort involved several partners who provided financial and in-kind contributions. The NH DES Watershed Assistance Section awarded the town of Stratford a $14,912 section 319 grant to partially fund survey, design, permitting, and construction. The property owner contributed $8,748 in additional funds. In-kind professional services for construction supervision comprised the remainder of the required nonfederal match. The total project cost $24,460.

Factor in Bog Brook channel stability	Reference stream	Bog Brook	
		Pre-construction	Post-construction
meander radius	80–120 ft.	40 ft.	92 ft.
channel slope	--	.081%	1.00%
vegetation	deep-rooted riparian shrubs	shallow-rooted (6-in.) grasses (e.g., timothy, reed-canary grass, Kentucky bluegrass, orchard grass)	deep-rooted riparian shrubs (e.g., alder, willow)

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
New York

Restoration and Protection Activities in the Upper Branch of the Delaware River Protects New York City's Drinking Water Supply

Waterbody Improved The Upper West Branch of the Delaware River is a significant source of drinking water for New York City (NYC). It directly feeds the Cannonsville Reservoir, the third largest reservoir serving NYC. Historically, the Cannonsville Reservoir experienced summertime eutrophic (low oxygen) conditions because of high phosphorus loads predominantly from nonpoint sources. New York State (NYS) placed the Upper West Branch of the Delaware River (UWBDR) on its 1998 303(d) list due to concerns about the vulnerability of the reservoir to additional sources of phosphorus. Because efforts by the local community and numerous other partners successfully reduced phosphorus loads, the state removed the UWBDR from its 2004 impaired water list.

Problem

The UWBDR is in Delaware County in south-central New York. The UWBDR and its tributaries encompass a watershed area of 450 square miles with approximately 662 linear miles of rivers and streams that are the source waters for the Cannonsville Reservoir. The 37.1-mile listed segment of the UWBDR begins near the Village of Stamford and runs to Chambers Hollow Brook. NYS listed this segment on its 1998 303(d) list of impaired waters for not meeting criteria to support its designated use—aquatic life support—due to excess phosphorus levels. The state's narrative standard states that phosphorus may not exist "in amounts that will result in growth of algae, weeds, and/or slimes that will impair the waters and their best usages."

NYC's Department of Environmental Protection completed a TMDL for phosphorus, which EPA approved in 2000. Forestry and agriculture represent 95 percent of the UWBDR's land use, and impacts from forestry, agricultural areas, and septic systems contribute to nutrient enrichment. NYC identified dairy farming and failing onsite septic systems as the most significant watershed sources of impairment to the UWBDR. Runoff from these sources carried excess phosphorus to the UWBDR, threatening to alter the natural aquatic community and compromise the reservoir as a source of high-quality drinking water.

Prior to the restoration work in the watershed, the UWBDR's tributaries frequently suffered from algae blooms caused by phosphorus inputs from agricultural runoff. This image shows a 1981 algae bloom that occurred on Trout Creek (Photo credit: Patricia Bishop, NY Dept. of Environmental Conservation).

Project Highlights

Delaware County worked with watershed partners to develop the Delaware County Action Plan (DCAP), a comprehensive watershed management program that provided a framework for protecting water resources through local decision making—within the context of state and federal laws. Through the DCAP, Delaware County has achieved many of the initiatives highlighted below. The accomplishments of the DCAP demonstrate the importance of managing land uses and nonpoint pollution sources at the local level.

The New York-based nonprofit Watershed Agricultural Council championed a voluntary, incentive-based program through which farmers implemented numerous best management practices (BMPs). The Watershed Agricultural Council encourages farmers to adopt and implement Whole Farm Plans (WFP) on dairy farms to successfully integrate traditional and innovative farm management approaches. These holistic farm plans (along with other nonpoint and point source reduction activities) helped reduce dissolved phosphorus loads in the UWBDR by 53 percent and particulate phosphorus loads by approximately 36 percent. The agricultural BMPs implemented through the WFPs included riparian buffers; alternate water sources for dairy cows; barnyard management improvements (waste removal, collection of polluted runoff); precision feeding (controlling nutrient excretions through diet management); and stream relocation.

A septic system repair and replacement program, overseen by the Catskill Watershed Corporation, also served as a key element of the UWBDR watershed protection and restoration program.

To ensure continued success, the Delaware County Soil and Water Conservation District worked with watershed stakeholders and cooperating agencies to develop a *West Branch of the Delaware River Stream Corridor Management Plan.* This plan provides a foundation for local residents, municipalities, interested organizations, and cooperating agencies to enhance stewardship of the UWBDR and its tributaries.

Results

Project partners conducted several monitoring activities in the UWBDR Basin, including a paired watershed study to evaluate water quality impacts of agricultural BMPs, biological assessment surveys, and ambient monitoring in the UWBDR and in the Cannonsville Reservoir. These monitoring activities showed a reduction in phosphorus enrichment in the UWBDR and the achievement of the state guidance limit of 20 micrograms per liter (μg/L) for reservoirs. These findings ensured that the drinking water supply was safe from eutrophic conditions and that the waterbody provided a healthy ecosystem for aquatic life. After the Cannonsville Reservoir met the state's guidance limit, NYC removed it from the *phosphorus restricted list* in 2002. This list, established by NYS regulations, limits the amount of phosphorus released in designated reservoir basins. In addition, survey data collected on the UWBDR indicated that the waterbody fully supported its designated uses and had no water quality impairments associated with the state's narrative standard for phosphorus. Therefore, NYS removed the UWBDR from the 303(d) list of impaired waters in 2004.

Partners and Funding

Many agencies participated in the restoration of UWBDR including the NYC Department of Environmental Protection, Soil and Water Conservation Districts, Delaware County Planning Department and Department of Public Works, Catskill Watershed Corporation, Watershed Agricultural Council, Upper Susquehanna Coalition, NYS Department of Environmental Conservation, NYS Department of Health, NYS Department of State, NYS Department of Transportation, NYS Department of Agriculture and Markets, NYS Soil and Water Conservation Committee, Cornell University, U.S. Environmental Protection Agency, U.S. Department of Agriculture, and U.S. Army Corps of Engineers. Funding for the phosphorus load reduction efforts came from many sources, including more than $420,000 from Clean Water Act section 319 funds.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
North Carolina

Watershed Partnership Pays Off for Brasstown Creek

Waterbody Improved

Eroding streambanks, runoff from agricultural lands, and livestock access caused widespread nonpoint source pollution problems in the Brasstown Creek watershed in the mid-1990s. By 1994 the creek had failed to meet aquatic life criteria and North Carolina had placed it on the state's 303(d) list due to sediment impairments. Public and private partners implemented several best management practices (BMPs)—restricting livestock access to the creek, providing livestock with alternative water sources, reconstructing stream channels, enhancing riparian buffers, and others—to reduce water quality impacts. Water quality improved enough to once again support a healthy macroinvertebrate community, and the state delisted Brasstown Creek in 2000.

Problem

Brasstown Creek originates in Georgia and flows generally northwest into North Carolina. From the Georgia–North Carolina border, the creek meanders 8.5 miles before reaching the Hiwassee River. The watershed has an 83-square-mile drainage area and contains low-density residential development, pasture and hay lands, and a relatively large amount of forest cover.

The North Carolina Division of Water Quality (NC DWQ) monitored macroinvertebrates in that state's portion of Brasstown Creek using two biological indices. The EPT index is a measure of pollution-sensitive aquatic insects inhabiting a waterbody. A stream showing high EPT richness is less likely to be polluted than one with low richness in the same geographic region. In addition, NC DWQ evaluated Brasstown Creek's biotic integrity (BI), which measures the presence of pollution-tolerant species. High BI values characterize streams that have poor water quality and are dominated by pollution-tolerant species.

The accompanying table shows biomonitoring results from Brasstown Creek. In 1994 the creek had an EPT index of 18. This low value caused the state to place an 8.5-mile segment of Brasstown Creek on its 303(d) list for only partially supporting state aquatic life use criteria. NC DWQ cited sediment from nonpoint sources, including streambank erosion and agricultural and highway runoff, as the causes of impairment. This assessment was supported by a Tennessee Valley Authority (TVA) analysis of land use in the Brasstown Creek watershed.

Before: Channel instability and bank erosion along this Brasstown Creek tributary were caused by historic channelization, lack of riparian vegetation, and cattle access.

Project Highlights

In response to these problems, in 1995 the Hiwassee River Watershed Coalition (HRWC) formed a locally driven partnership to restore the watershed and implement numerous BMPs. The partners revegetated 160 acres of critically eroding bare areas (lands within 1,000 feet of streams); installed nearly 6.2 miles of

After: The rebuilt channel was designed with a more stable pattern, modeled after a similar, relatively undisturbed stream.

livestock exclusion fencing; reconstructed stream channels; and created, enhanced, or protected 48 acres of forested riparian buffer from 1999 through 2004. In addition, project partners installed stock trails, stream crossings, wells, and spring developments in heavy-use areas, thereby improving more than 2,000 acres of pastureland. These practices kept an estimated 650 tons of soil, 162 pounds of nitrogen, and 45 pounds of phosphorus out of Brasstown Creek annually.

Results

NC DWQ sampled Brasstown Creek again in 1999 and found that although instream habitat and sedimentation problems remained, the benthic macroinvertebrate community showed a marked improvement. Evaluating EPT and BI indices, NC DWQ assigned Brasstown Creek a "Good" bioclassification, indicating that the creek met its aquatic life support designation and allowing North Carolina to delist it in 2000. Subsequent monitoring in 2004 reaffirmed that the benthic community had recovered.

Year	EPT	BI	State bioclassification
1994	18	--	Fair
1999	44	4.6	Good
2004	53	4.8	Excellent

Brasstown Creek biomonitoring results. NC DWQ assessed EPT and BI to assign a bioclassification for the creek. A "Good" or "Excellent" bioclassification indicates that the creek meets its aquatic life support designation.

Other signs of water quality improvement in Brasstown Creek have been noted. A pollutant loading model developed by TVA, for example, showed a nearly 25 percent reduction in total suspended solids (TSS) for the North Carolina portion of the Brasstown Creek watershed between 1997 and 2004. Even greater TSS reductions—up to 83 percent—occurred in some subwatersheds where several BMPs were in close proximity.

Success is not yet complete for the entire watershed, however. Upstream portions remain listed as impaired or partially supporting their designated uses. The HRWC and its partners plan to implement similar restoration work in the Georgia portion of the watershed.

Partners and Funding

The HRWC spearheaded the Brasstown Creek Watershed Restoration Project and was joined by government and non-government partners. These included NC DWQ; Clay County (North Carolina), Cherokee County (North Carolina), and Blue Ridge Mountain (Georgia) Soil and Water Conservation Districts; TVA; North Carolina Division of Soil and Water Conservation (Agriculture Cost Share Program); USDA Natural Resources Conservation Service; and 47 private landowners.

Nearly $4 million has gone toward the Brasstown Creek watershed recovery effort. Agricultural BMPs were implemented with approximately $450,000 in section 319 funds, $400,000 from the North Carolina Agriculture Cost Share Program and the federal Environmental Quality Incentives Program, and $127,500 in landowner cost share payments. The North Carolina Clean Water Management Trust Fund provided an additional $2.5 million for stream and riparian buffer restoration. Finally, TVA contributed an approximately $500,000 in-kind donation for technical support and watershed modeling.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

North Carolina

Aquatic Life Use Restored in Agricultural Watershed

Waterbody Improved

Agricultural runoff decimated macroinvertebrate life in a 1.9-mile segment of the Mills River in western North Carolina. Because the segment failed to meet aquatic life criteria, North Carolina placed it on the state's 303(d) list of impaired waters in 1998. Local and state water quality experts worked with the community to implement several best management practices, including moving pesticide mixing stations away from river banks and restoring vegetated buffers. Water quality improved enough to once again support macroinvertebrate life, and the state expects to remove the river segment from its 303(d) list in 2006.

Problem

The Mills River supplies drinking water for more than 50,000 people in three western North Carolina counties. Areas upstream from the town of Hendersonville are home to many intensely managed agricultural activities, including the production of cattle and specialty crops such as tomatoes. Officials suspected that these operations contributed sediments and pesticides to a 1.9-mile river segment extending upstream from the town's water intake.

The state conducted benthos sampling in the river segment and used the EPT index to measure the presence of pollution-sensitive aquatic insects. The index assumes that a waterbody showing high EPT richness is less likely to be polluted than another waterbody with relatively low EPT richness in the same geographic region. In addition, the state measured biotic integrity (BI) in the river segment. A low BI value indicates better water quality than a high BI value.

As shown in the accompanying table, monitoring results from both indices revealed that the segment met state water quality standards for aquatic life support in 1997. In subsequent years, however, the North Carolina Division of Water Quality (NC DWQ) found much lower EPT and higher BI values, indicating a decline in water quality. In 1998, NC DWQ assigned a *Poor* rating to the river segment and placed it on the state's 303(d) list.

This chemical-handling facility replaced one that was directly adjacent to Mills River.

Year	EPT	BI	State assessment rating
1997	24	5.17	Good-Fair
1998	2	6.69	Poor
2001	6	--	Poor
2002	28	5.54	Good-Fair

Mills River biomonitoring results using the EPT index and BI. Low EPT/high BI indicate poor water quality, while high EPT/low BI suggest good water quality.

Project Highlights

State and local water quality experts teamed with landowners and other organizations to address suspected pollutant loading sources

Streambank and buffer restoration shortly after tree planting. Small trees are in the tall grass on the left.

to the river segment. Project partners obtained three conservation easements totaling 192 acres, designated and planted 7.8 acres of riparian buffers, and restored nearly 4,700 linear feet of streambanks. In addition, they moved two chemical mixing stations away from river tributaries.

To address the sources of sediment, project partners stabilized 10 miles of logging roads, installed 2,580 linear feet of cattle fencing, and created 400 feet of stock trails to reduce cattle traffic on steep slopes. Area cattle operations received two water tanks, further helping to keep cattle away from streams.

Public outreach also played a role in the restoration effort. Workshops educated local agriculture producers about the dangers of pesticides in the river. Local residents received general watershed education.

Finally, project partners established a stormwater monitoring program in 2001.

Results

Restoration efforts resulted in dramatic water quality improvements, as confirmed by benthic monitoring. In 2002, NC DWQ macroinvertebrate sampling showed a much richer EPT index of 28 and a stronger BI of 5.54. Both indices placed the river segment in the *Good-Fair* assessment rating, placing the river segment in compliance with its aquatic life support designation. With such a positive result, North Carolina expects to remove this river segment from its 303(d) list in 2006. Macroinvertebrate monitoring will continue, with the next sampling event scheduled for the summer of 2007.

Gains will be lost, however, if work does not continue. The Mills River watershed is in western North Carolina's fastest growing area. Keeping pace with development impacts is essential if designated uses are to be sustained. The state's future plans include restoring a mile of vegetated buffer and constructing a chemical mixing building that will eliminate two additional streamside mixing stations.

Partners and Funding

Numerous groups worked together successfully to restore this segment of the Mills River. The NC DWQ supported the work with a 319 grant of $448,000. The state's Clean Water Management Trust Fund provided $730,000, and the partners used a $50,000 EPA Source Water Protection grant to create land conversion inventories and hold meetings and workshops.

Many agencies and organizations contributed services and funds, including North Carolina's Divisions of Forest Resources and Soil and Water Conservation; N.C. Ecosystem Enhancement Program; N.C. Wildlife Resources Commission; N.C. State University Mountain Horticultural Crops Research Station; Henderson County; Henderson County Soil and Water Conservation District; Environmental Conservation Organization of Henderson County; U.S. Environmental Protection Agency, Forest Service, and Natural Resources Conservation Service; Carolina Mountain Land Conservancy; City of Asheville's Water Treatment Plant; City of Hendersonville; Cross Creek Foundation; Land of Sky Regional Council; Tennessee Valley Authority; Trout Unlimited (Land of Sky Chapter); North and South Mills River Community Development Center; Regional Water Authority of Asheville, Buncombe and Henderson Counties; University of North Carolina at Asheville's Environmental Quality Institute; and Mills River Partnership.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

North Carolina

Tar-Pamlico Basin Agricultural Management Strategy Reduces Instream Nutrients

Waterbody Improved Row crops and animal feeding operations in the Tar-Pamlico River Basin, one of three main feeders to the nation's second largest estuary—the Albemarle-Pamlico Sound—have led to excessive nutrients in the estuary, forcing it to be added to the state's 303(d) list for chlorophyll *a*. Through implementation of best management practices (BMPs) on agricultural lands, such as riparian buffer protection, reduced fertilizer use, and implementation of conservation tillage practices, North Carolina met its 30 percent nitrogen reduction goal ahead of schedule and impaired acreage in the estuary was reduced by 90 percent, allowing one section of the estuary to be removed from the 303(d) list for chlorophyll *a*.

Problem

In the mid-1980s, the Pamlico River estuary saw an increase in problems that pointed to excessive levels of nutrients in the water—harmful algal blooms, low oxygen levels, increased numbers of fish kills, and other symptoms of stress and disease. Row crops, confined animal feeding operations, and highly erodable soils were the culprits. The Pamlico River estuary was eventually placed on the 303(d) list for chlorophyll *a*, driven by excess nutrient concentrations contributed by agricultural runoff and point sources.

Area farmers installed water table control structures like the one shown here to address excess nutrients.

Project Highlights

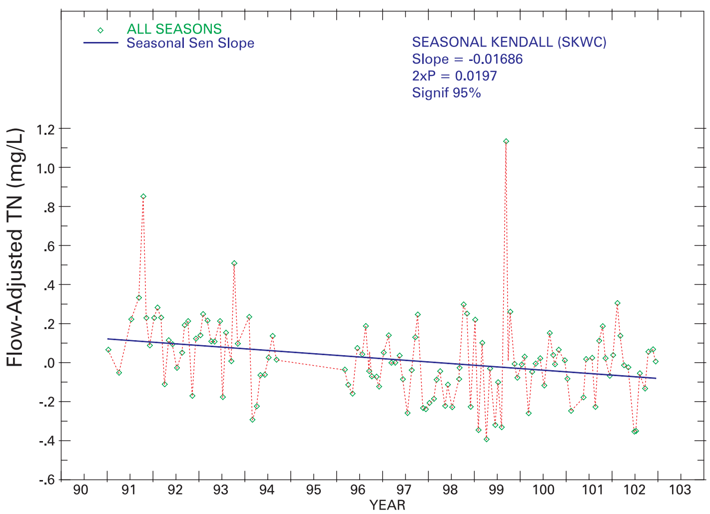
In response, the North Carolina Environmental Management Commission designated the Tar-Pamlico River Basin as "Nutrient Sensitive Waters" and called for a strategy to reduce nutrient inputs from around the basin. The strategy's first phase, which ran from 1990 through 1994, produced an innovative point source/nonpoint source trading program that allows point sources, such as wastewater treatment plants and industrial facilities, to achieve reductions in nutrient loading in more cost-effective ways. The group cap structure of the trading program has allowed the point source coalition to exceed its reduction targets so cost-effectively that nonpoint source trades have been unnecessary to date. The second phase established a plan to reduce nitrogen by 30 percent (from 1991 levels) and hold phosphorus loadings to 1991 levels based on estuarine conditions by 2006, implementing the targets set in the total maximum daily load (TMDL) for chlorophyll *a*. In addition to point sources, Phase II called on nonpoint sources to contribute to meeting these goals and established a set of nonpoint source rules addressing agriculture, urban stormwater, and fertilizer management across all land uses and called for riparian buffer protection. Between

1991 and 2003, farmers installed water control structures to treat 32,200 acres of cropland, buffers to treat 72,000 acres and planted scavenger crops on 81,500 acres. In addition, many farmers reduced fertilizer use and implemented conservation tilling practices to help meet the goal. The third phase of the nutrient strategy was adopted by the EMC effective April 14, 2005, setting an eight year clean-up deadline for the rest of the estuary by 2013.

Results

Agriculture met its 30 percent nitrogen reduction goal ahead of schedule. In fact, data from 2003 indicate a 45 percent reduction in nitrogen losses compared to 1991, mostly from decreasing fertilization rates. Progress is further reflected by samples taken at the Pamlico estuary's head showing an 18 percent instream reduction in nitrogen and a 33 percent instream decrease in phosphorus between 1991 and 2002, reflecting significant progress toward meeting the targets set in the TMDL. The installation of BMPs in the watershed has prevented more than 396,000 tons of soil from being washed away by erosion. As a result of watershed-wide efforts, impaired acreage in the estuary has been reduced by 90 percent (from 36,200 to 3,450 acres), and one segment of the Pamlico estuary has been removed from the 303(d) list for chlorophyll *a*.

Sampling at Pamlico Estuary



Samples reflect an 18 percent instream reduction in nitrogen.

Partners and Funding

Partners involved in the effort were North Carolina Division of Water Quality, Soil and Water Conservation Districts, North Carolina Division of Soil and Water Conservation, North Carolina Cooperative Extension, U.S. Department of Agriculture's Natural Resources Conservation Service, North Carolina Department of Agriculture, North Carolina Farm Bureau, North Carolina State University, and agricultural community and commodity groups. The North Carolina Environment Management Commission brought together stakeholder groups of affected parties and provided the participants with a chance to express differing viewpoints. Stakeholders involved in the process included environmental groups, municipalities, developers, businesses, and the public. The North Carolina Agriculture Cost Share Program, administered by the Division of Soil and Water Conservation (DSWC), contributed $12.5 million between 1992 and 2003. Another DSWC-administered program, the federal Conservation Reserve Enhancement Program, has obligated approximately $33.1 million in the Tar-Pamlico River Basin since 1998. Between 1995 and 2003, approximately $2.67 million in Clean Water Act section 319 expenditures supported a variety of nonpoint source projects in the Tar-Pamlico Basin, including BMP demonstration and implementation, technical assistance and education, GIS mapping, development and dissemination of accounting tools, and monitoring. As part of the Phase I Agreement, the area's Point Source Association both contributed funds and acquired a section 104(b)(3) grant for agricultural BMP implementation. The combined total of their contributions was $850,000 in nutrient-reducing BMPs in the basin.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Ohio

Dam Modification Project Helps Restore Water Quality in the Middle Cuyahoga River

Waterbody Improved The Kent Dam on Ohio's Middle Cuyahoga River was a barrier to fish migration and contributed to water quality problems due to stagnant flows within the dam pool, preventing the river from meeting its designated use for warmwater habitat (WWH). As a result of modifications to the dam that restored a free flowing river channel and other activities implemented both above and below the dam, the Cuyahoga River is now meeting the full attainment of its WWH aquatic life use designation, and it is expected to be removed from the state's 303(d) list of impaired waters in the next listing cycle.

Problem

In 1999 the Ohio Environmental Protection Agency (Ohio EPA) completed a total maximum daily load (TMDL) study on the Middle Cuyahoga River that found the river was only partially attaining objectives for its WWH designation. In 2000 it was placed on the state's 303(d) list as impaired by nutrients, siltation, low dissolved oxygen, flow alteration, and other habitat alteration. Major sources of impairment included municipal point sources, combined sewer overflows, septic systems, urban runoff, channelization, and dam construction. The TMDL indicated that point source regulation alone would be insufficient to achieve water quality goals within the river and recommended the modification or removal of dams in the cities of Kent and Munroe Falls.

Ohio EPA determined that the Kent Dam was contributing to water quality problems due to stagnant flows and eutrophication within the dam pool, causing dissolved oxygen levels to fall well below water quality criteria during periods of low flow. The dam pool altered aquatic habitat, impairing both the health and diversity of indigenous fish species. Additionally, the dam posed a physical barrier to fish migration.

The dam pool was eliminated by removing an old canal lock and allowing the river to return to free-flowing conditions.

Project Highlights

The Middle Cuyahoga River Restoration Project required consideration of complex science and engineering, cultural and archaeological sensitivity, regulatory finesse, and public involvement. The Kent Dam project initially faced fierce public resistance due to the dam's historic value and location in a designated historic district. The dam itself was listed on the National Register of Historic Places because it was one of the first recorded arched dams constructed in the United States.

An independent committee composed of the general public and various local, state, and federal representatives determined that the dam could be successfully modified without destroying its historic character. The project involved removing an old canal lock east of the dam to provide for a free-flowing river channel, while at the same time preserving and restoring the arched dam structure. The former dam pool area was converted into Heritage Park, and extensive interpretative signage chronicles the history of the area as well as the environmental benefits of the project. To further restore water quality and aquatic habitat, the project incorporated extensive natural stream channel and streambank restoration above the dam.

Results

Prior to the project, the Index of Biological Integrity (IBI)—an objective measurement of the diversity of the fish community—indicated that fish life within the river failed to meet WWH standards. Physical habitat conditions within and along the river were measured using the Qualitative Habit Evaluation Index (QHEI) and also failed to meet WWH standards.

Following completion of the Middle Cuyahoga Restoration Project, IBI scores within the Kent Dam area increased by 57 percent and QHEI scores increased by 56 percent. Modified Index of Well Being (MiWb) scores—used to measure the general health of fish communities within a waterbody—increased slightly from 8.2 to 8.9. As a result, the Cuyahoga River fully attained its WWH aquatic life use designation, and it is expected to be removed from the state's 303(d) list of impaired waters in the next listing cycle.

Ohio EPA Kent Dam Pool Bio-Survey Data

	Pre-Construction	Post-Construction
IBI	28.0	44.0
MiWb	8.2	8.9
QHEI	51.0	79.5
WWH Criteria: IBI ≥ 40; MiWb ≥ 7.9; QHEI ≥ 60		

As an additional benefit, the city of Kent saved several million dollars in wastewater treatment upgrades that otherwise would have been required to address impairments caused by the dam. Developing the city of Kent's Heritage Park in the former dam pool also preserved an important connection to Ohio's history. Continued water quality improvements are expected upon the completion of additional projects such as modification of the dam downstream at the city of Munroe Falls.

Partners and Funding

The city of Kent, in partnership with the cities of Ravenna and Massillon, Summit County, and agencies such as the U.S. EPA, Ohio EPA and Ohio Department of Natural Resources (ODNR), secured more than $5 million for the Kent Dam Project. Funding was provided as follows: Ohio EPA's Clean Water Act (CWA) State Revolving Loan Fund's Water Resource Restoration Sponsor Program—$3.94 million; The Clean Ohio Fund—$636,000; CWA section 319 Grant—$500,000; and ODNR—$6,400. The section 319 grant funds were used to restore degraded and exposed streambanks following removal of the dam pool.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Oklahoma

BMPs Result in Significant Reduction of Bacteria and Phosphorus Loading

Waterbody Improved

Beaty Creek, in northeast Oklahoma, was impaired for pathogens, specifically *E. coli* and *Enterococcus*, due in part to poor waste management practices and direct access of livestock to the stream. Landowner education and implementing best management practices (BMPs) to promote proper animal waste and nutrient management, as well as better riparian zone management have led to significantly decreased amounts of bacteria in the creek. As a result, Oklahoma expects to remove Beaty Creek from its 2006 303(d) list for *E. coli* impairment. In addition, expected phosphorus loading to Beaty Creek is also decreasing as compared to a control watershed with no BMP implementation.

Problem

The Beaty Creek watershed contains approximately 39 chicken houses; hog and turkey operations; and extensive, streamside cattle grazing on pasture fertilized with animal waste. Septic systems, land development, some row crop agriculture and fertilizer application are also found in the watershed. These activities have cumulatively generated a high amount of nonpoint source pollution and resulted in elevated levels of bacteria in Beaty Creek. In 2002, Oklahoma placed all 13 miles of Beaty Creek on the 303(d) list as impaired for *E. coli* and *Enterococcus*. In addition, high levels of phosphorus loading contributed to eutrophication and phosphorus exceedance in Lake Eucha, a downstream reservoir.

Project Highlights

The number one restoration priority for the Beaty Creek area was riparian buffer establishment and protection. Another focus was disseminating information on pasture management and proper application of poultry litter as fertilizer—key issues in the watershed. Numerous educational workshops, meetings, and tours demonstrating BMPs in the watershed were essential for the success of this project. Approximately 63 percent of landowners in the watershed implemented BMPs through cost-share contracts from 2000 to 2004.


Areas for cattle feeding and waste storage were constructed to reduce the amount of bacteria and nutrients entering the stream.

Results

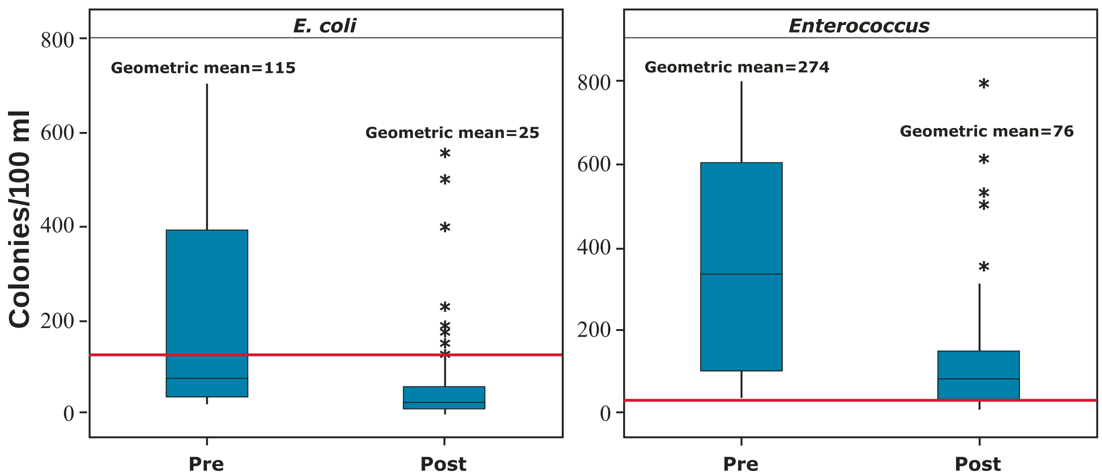
Attendance was high at the various educational presentations. Approximately 100 cost-share contracts to implement BMPs in the Beaty Creek watershed were signed into action in both Oklahoma and Arkansas. BMPs included establishing 335 acres of riparian buffer areas, establishing/managing approximately 10,000 acres of pasture; the provision of more than 150 alternative water sources for cattle; the construction of 56 heavy use areas, 16 cattle feeding/waste storage facilities, 31 miles of cross fencing, four poultry waste storage facilities; and the replacement of 27 septic systems. Resulting water quality improvements led to Beaty Creek being nominated for removal from the 2006 303(d) list for *E. coli*. This brings it one step closer to full attainment of the Primary Body Contact Recreation (PBCR) beneficial use.

In addition, BMPs have reduced the expected loading of phosphorus in the Beaty Creek watershed as compared to a control watershed with no BMPs. Analysis of water quality data collected after the implementation of the Beaty Creek BMPs indicates that the increasing trend is no longer evident, which, in itself, is a measure of success. Independent analysis of water quality data, conducted by Oklahoma State University, using a paired watershed methodology showed a 31 percent decrease in expected phosphorus loading to the lake from Beaty Creek in the presence of BMPs, compared to expected loading in the absence of BMPs. Average flow-weighted phosphorus concentrations decreased from 0.220 mg/L to 0.191 mg/L. Although phosphorus loadings are still significant, the rate of phosphorus loading has been reduced. BMP implementation to reduce nutrient loading and evaluation of the stream continues.

The success of this project and continued interest in implementing BMPs has allowed the pursuit of a related project in the adjoining Spavinaw Creek watershed. One of the greatest successes of the project is that landowners are beginning to implement the practices without the benefit of cost-share assistance, and they are requesting assistance with BMP design and using their own funds. Even landowners outside the watershed are interested in the practices that were demonstrated in Beaty Creek and are beginning to implement them.

Partners and Funding

A total of $1,338,401 was available to support installation of the BMPs associated with this project. This included $632,467 federal dollars from EPA section 319 funds, $528,133 state dollars, and a required $177,800 match from landowners. The Eucha watershed has been a special emphasis area for Oklahoma's EQIP program, ensuring that at least $325,000 worth of additional practices were implemented throughout the watershed. Different groups participating in the Beaty Creek project included the Oklahoma Conservation Commission, Delaware County, Oklahoma and Benton County, Arkansas Conservation Districts, Oklahoma Department of Agriculture, Oklahoma State University Cooperative Extension Service, NRCS, Farm Services Agency, Arkansas Soil and Water Conservation Commission, local producers, poultry integrators, and animal waste marketers.



Boxplots indicate the interquartile range (25^{th}–75^{th} percentile) and median of the data in each of two periods: "Pre" contains data from August 1999 to January 2001; "Post" includes data from July 2001 to May 2005. The red line indicates the geometric mean above which the beneficial use is not achieved. There were significant reductions in mean levels of both *E. coli* and *Enterococcus* bacteria.

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Improvement of Surface and Ground Water Quality

Waterbody Improved Lake Creek, in Caddo County, is in one of Oklahoma's most intensive agricultural areas. Conducting educational programs and implementing best management practices (BMPs) decreased loading of pesticides, nutrients, and sediment to the creek. As a result, fish communities improved enough to allow removal of Lake Creek from Oklahoma's 303(d) list in 2002 for pesticides and unknown toxicity. Further water quality improvements are ongoing in this region as part of the Fort Cobb Watershed Based Plan.

Problem

Lake Creek is a 16-mile-long gaining stream fed by shallow ground water that seeps out continuously along the stream banks. Approximately 92 percent of the Lake Creek watershed is used for producing peanuts, cotton, wheat, alfalfa, and other small grain and row crops. Excessive and improper fertilization and pesticide use, along with shallow ground water and very permeable and highly erodible sandy soils led to creek impairments. High levels of nutrients and unknown toxicity thought to be related to pesticides were detected in surface and ground water. Approximately 12 pesticides and the fungicide Botran were detected in surface water and streamside seepage samples. Fish samples at two sites along Lake Creek in 1990 revealed very poor biological conditions relative to area reference streams, based on IBI (Index of Biological Integrity) scores. Because of these results, Oklahoma placed Lake Creek on the 303(d) list in 1998 as not supporting its Fish and Wildlife Propagation (FWP) beneficial use because of unknown toxicity and pesticide impairment.

Project Highlights

An educational effort on reducing fertilizer and chemical usage targeted landowners and highlighted the benefits of potential cost savings. One-on-one meetings and public sessions were held to teach peanut and alfalfa growers integrated pest management techniques including proper weed and insect scouting, determining pest thresholds, interpreting soil test reports and proper fungicide use. Demonstration BMPs illustrated techniques to manage vegetation; exclude cattle from riparian zones; and reduce nutrient, pesticide, and sediment loading. BMPs implemented from 1995 to 2002 included reduced tillage planting in peanut fields, riparian fencing, alternative livestock water source construction, grade stabilization structures, diversion terraces, deferred grazing, rotational grazing, and revegetation in riparian zones.

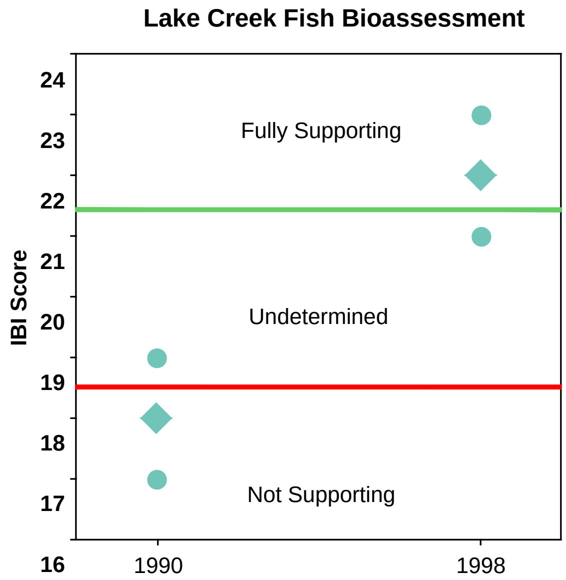
Results

More than 200 people attended the various educational presentations. More than 400 acres of pasture were converted to deferred or rotational grazing. Grade stabilization and diversion terrace structures were constructed. Approximately 20,000 feet of stream exclusion fencing was erected, and vegetation was planted in critical riparian areas. As a result of these practices and the accompanying educational program for proper pesticide and fungicide use, the fish community improved significantly.

The median number of species caught in 1998 was 13.5, compared to 6 in 1990, and the median number of fish caught in 1998 was 637, compared to 299 in 1990. The increase in these parameters improved the IBI scores for Lake Creek to the degree necessary to fulfill the state biological criteria in support of the FWP beneficial use. Additionally, samples of Lake Creek water and sediment failed to exhibit any toxicity using the same tests that had demonstrated toxicity in 1990. Because of these results, Oklahoma removed Lake Creek from the 303(d) list for unknown toxicity and pesticides in 2002.

Partners and Funding

Many groups contributed to the success of this project. Crucial educational efforts were led by the Oklahoma Cooperative Extension Service and the Oklahoma Department of Agriculture (now Oklahoma Department of Agriculture, Food and Forestry) with the participation of the other agencies. EPA section 319 funds provided $280,441, while the State of Oklahoma supplied $186,961 toward the Lake Creek project.



Fish bioassessment results from 1990 and 1998. Circles represent the IBI scores of fish collections at two sites in Lake Creek; diamonds indicate the average IBI score of the two sites. The improvement in these parameters resulted in an average IBI score that justified delisting (Oklahoma biocriteria allows pooling of data from multiple sites when they lie within the same reach).

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Education and Demonstration Efforts Result in Turbidity Improvements

Waterbody Improved Sandy and Yellowstone Creeks, both in the Salt Fork of the Arkansas River watershed in north central Oklahoma (in Alfalfa and Woods Counties, respectively), were impaired for turbidity due in part to practices associated with crop and cattle production. Agricultural producer education and implementation of best management practices (BMPs) to promote conservation tillage, proper fertilizer application, integrated pest management, and riparian buffer establishment helped to decrease sediment and nutrients going into both creeks. As a result, Oklahoma removed Sandy Creek from its 2004 303(d) list for turbidity impairment, and nominated Yellowstone Creek for removal from the state's 2006 303(d) list for turbidity.

Problem

The Salt Fork is an agriculture-intensive watershed where wheat and alfalfa are the primary crops. Producers often plowed fields to the edge of streams, and cattle often grazed at stream edges, both of which contributed to bank erosion. Consequently, streams in this watershed had high turbidity problems. Oklahoma placed both Sandy Creek, 18 miles long, and Yellowstone Creek, 22 miles long, on the 1998 303(d) list for not attaining their designated use of Fish and Wildlife Propagation (FWP) because of turbidity impairment.

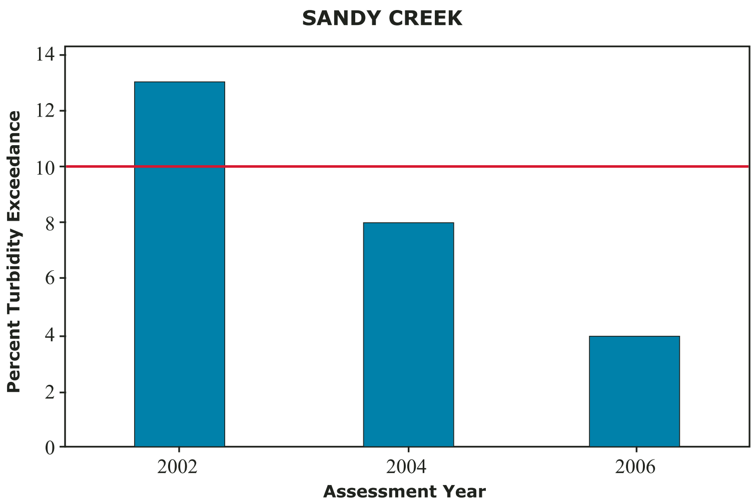
Potential sources of sediment and nutrients in the Salt Fork watershed before implementing the BMPs: fields were often cultivated or grazed to the edge of the stream; riparian buffers were nonexistent or rare.

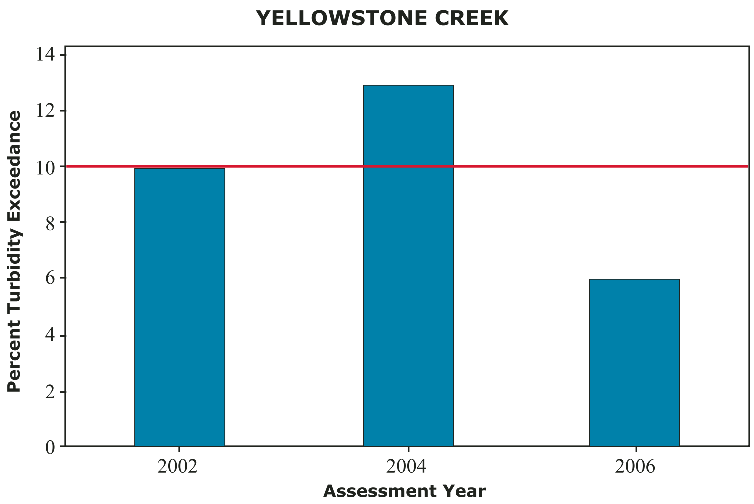
Project Highlights

Educating agricultural producers was a top priority for the Salt Fork watershed program. Better management techniques for sediment, nutrient, and pest control, such as no-till and reduced-till planting; proper fertilizer and chemical (pesticide, herbicide, fungicide) application; the use of crop varieties that require fewer chemicals; and riparian buffer zone establishment were taught through multiple channels. Ten BMP demonstration projects showed producers that BMP implementation need not affect their bottom line or production volumes. Numerous educational meetings, tours, and field days, in combination with a Web site and newsletters also promoted the BMPs.

Results

During the project period, from 1999 to 2002, conservation tillage use within the Salt Fork watershed increased by 21 percent (to 88 percent of producers), soil test-based fertilizer application increased by 29 percent (to 67 percent of producers), and 78 percent of producers recognized the benefits of using vegetative





A stream is considered impaired due to turbidity if 10 percent or more of the seasonal base flow water samples exceed 50 NTUs (based on 5 years of data preceding the assessment year). Both creeks now fully attain their FWP use designation.

buffers along streams. As a result, turbidity has decreased in the Salt Fork watershed. In the 2002 assessment, 13 percent of seasonal base flow water samples from Sandy Creek exceeded the turbidity criteria; in the 2004 assessment it was reduced to 8 percent. In 2006, it was further reduced to 4 percent. Similarly, in 2002, Yellowstone Creek had a 10 percent exceedance of turbidity criteria, which, by 2006, was down to only 6 percent exceedance. Both creeks now meet the requirements of their FWP use designation. Oklahoma removed Sandy Creek from its 303(d) list in 2004, and it expects to remove Yellowstone Creek from its 2006 303(d) list.

Partners and Funding

EPA section 319 funds provided $90,000 for the implementation of this project. The Oklahoma Conservation Commission supplied $60,000, which was used to subcontract with the Oklahoma State University Cooperative Extension to conduct education and demonstration tasks.

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Washington, DC

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Pennsylvania

Stream Restoration and Dam Removal Restore Waterbodies

Waterbody Improved Many years of agricultural runoff had caused nutrient and dissolved oxygen impairments in Manatawny Creek and an unnamed tributary to the Manatawny. In addition, an orphaned dam on the creek had blocked migratory fish access and triggered sediment accumulation in the stagnant waters. By 1998 Pennsylvania had included approximately 22.3 miles of Manatawny Creek and its tributary on the state's 303(d) list, citing sediment, nutrients, low dissolved oxygen, and thermal impairments due to agriculture and hydromodification. To address these problems, project partners stabilized stream channels, restored riparian buffers, and removed the dam. Water quality improved as a result, allowing the state to delist both waters in 2004.

Problem

The Manatawny Creek watershed covers 91.6 square miles and includes parts of two counties in southeastern Pennsylvania. The creek drains into the Schuylkill River at the town of Pottstown, approximately 40 miles northwest of Philadelphia.

Although urbanization is taking place throughout the watershed, much of the area remains in agricultural use. Nonpoint source runoff from agricultural fields and operations delivered high nutrient and sediment loads to Manatawny Creek and its tributaries. Algal blooms and low dissolved oxygen levels were pervasive issues.

An orphaned dam near the mouth of the creek compounded the upstream problems in both Manatawny Creek and an unnamed tributary to the Manatawny. The dam blocked migratory fish passage and caused stagnant flows, which allowed sediment to accumulate.

These circumstances prompted the Pennsylvania Department of Environmental Protection (PA DEP) to place approximately 20 miles of Manatawny Creek and 2.3 miles of the tributary on the state's 303(d) list of impaired waters for failing to meet aquatic life uses. The agency identified several causes of impairment, including

- Low dissolved oxygen concentrations triggered by nutrient-rich agricultural runoff

Restored riparian buffer along Manatawny Creek.

- Accumulated sediments from runoff and dam-caused streamflow stagnation
- Water temperature increases produced by stagnant waters

Project Highlights

Project partners employed several approaches to address the water quality troubles. First, they removed the dam in 2000, restoring the flow of the Manatawny and the tributary. Next, they stabilized approximately 2,000 linear feet of stream channel to reduce erosion. Finally, to further deal with erosion and to reduce nutrients entering the waterway, project partners restored nearly 2,000 linear feet of riparian buffers. These actions helped to reduce annual sediment loads to Manatawny Creek by an estimated 800 tons.

In addition to engineering approaches, project partners used public education throughout the project's duration. They conducted public meetings on the dam removal project, participated in formal meetings with borough officials and residents to discuss riparian vegetation management, and distributed project information through print and television media.

Results

PA DEP reassessed Manatawny Creek and its tributaries in 2002. By that time, the state had changed its 303(d) listing and delisting methodologies. When Manatawny Creek had been listed in the mid-1990s for not meeting aquatic life uses, the state had based its decision on chemical parameters like nutrients and dissolved oxygen. Later, as part of programmatic changes in Pennsylvania's total maximum daily load (TMDL) program, the state revised its criteria to base them primarily on benthic macroinvertebrate data.

As shown in the accompanying table, state biologists found that Manatawny Creek's macroinvertebrate populations consisted largely of pollution-sensitive taxa comparable to those found at reference locations. In addition, PA DEP showed that dissolved oxygen consistently remained above the state standard of 5 mg/L.

On the basis of these findings, Pennsylvania removed 20 miles of Manatawny Creek and 2.3 miles of the unnamed tributary from its 303(d) list of impaired waters. Project partners attribute the delisting of these waterbodies to the dam removal and stream restoration efforts.

Partners and Funding

Using a $90,000 section 319 grant, the Delaware Riverkeeper Network spearheaded efforts to stabilize streambanks and restore riparian areas. The Academy of Natural Sciences' Patrick Center for Environmental Research used a PA DEP Growing Greener grant to assess the effectiveness of dam removal as a river restoration method. The Pennsylvania Fish and Boat Commission oversaw the actual dam removal.

Additional partners included Greater Pottstown Watershed Alliance; Borough of Pottstown (Parks and Recreation); U.S. Fish and Wildlife Service; PA DEP; U.S. Environmental Protection Agency's Nonpoint Source Program; Montgomery County Conservation District; Pennsylvania Fish and Boat Commission; and Berks County Conservancy.

	Number of macroinvertebrate taxa						
Sensitivity rating	Station 1	Station 2	Station 3	Station 4	Station 5	Reference Station 1	Reference Station 2
Sensitive	5	7	7	7	7	7	5
Facultative	9	10	10	13	9	9	12
Tolerant	0	0	0	1	1	2	2

Macroinvertebrate data for Manatawny Creek in 2002 after stream restoration and dam removal. The table shows the number of pollution-sensitive, facultative, and pollution-tolerant taxa for five sampling stations and two reference sites. Taxa distribution in sampling stations compared favorably with that of reference sites. This finding, in part, led to the delisting of Manatawny Creek and an unnamed tributary.

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Homeowners and Agricultural Community Reduce Bacteria Levels in Oconee County Watersheds

Waterbody Improved

Livestock operations and failing septic systems caused excessive fecal coliform levels in two rural South Carolina creeks. In 1998 the state placed three sites (i.e., waterbody segments) along Coneross and Beaverdam Creeks on its 303(d) list for violating bacterial indicator water quality standards. The three watersheds represented by these sites did not support recreational uses because of the bacterial impairment. The South Carolina Department of Health and Environmental Control (SCDHEC) developed total maximum daily loads (TMDLs) for fecal coliform for Beaverdam Creek and two sites within Coneross Creek. Public and private partners met these TMDLs by implementing several best management practices (BMPs) designed, in part, to help the creeks meet state water quality standards for fecal coliform. At the close of the project in December 2005, all three sites were meeting South Carolina's water quality standards for fecal coliform.

Problem

Coneross and Beaverdam Creeks flow though Oconee County in the northwest corner of South Carolina. Water quality monitoring data within the two rural watersheds showed that three sites consistently exceeded state water quality standards for fecal coliform. As a result, South Carolina placed two sites on Coneross Creek and one site on Beaverdam Creek on its 303(d) list for fecal coliform bacteria violations. These watersheds encompass 47,016 acres in Coneross Creek and 9,099 acres in Beaverdam Creek. Staff at SCDHEC attributed the violations to failing septic systems and runoff from animal management sites. South Carolina removed the Beaverdam Creek site from the 303(d) list in 2000 and the Coneross Creek site in 2002 because a TMDL had been developed and approved for each station. However, water quality standards were not met at any of the three sites until 2005.

Project Highlights

In 2002 South Carolina initiated a 3-year project to develop and implement three fecal coliform TMDLs for the creeks. To effectively meet the TMDLs, project partners developed a watershed-based plan that targeted the agricultural community and homeowners with septic systems needing repair or replacement.

This alternative watering source on the Hendrix Farm keeps cattle out of nearby creeks and ponds.

The plan included an extensive community education component. Through various outreach efforts, project partners improved homeowner awareness of the importance of proper septic system maintenance. Outreach to the agricultural community included information about various BMPs to improve water quality.

By 2005, homeowners and farmers had taken many steps to improve Coneross and

This septic tank was completely filled with solids. Cooperators removed the solids and replaced the tank.

Beaverdam Creeks. Using the technical and financial support of project partners, homeowners repaired or replaced 38 failing septic systems. Likewise, project partners helped the agricultural community to adopt 80 BMPs, which included planting buffers and field borders, fencing cattle from creeks and providing alternative water sources, building waste-storage sheds, and installing compost facilities.

Results

Monitoring data from SCDHEC show that the efforts of the project team members, homeowners, and the agricultural community resulted in a measurable reduction in fecal coliform in Coneross and Beaverdam Creeks. By the end of the project in December 2005, data from each of the three stations showed that the water was meeting water quality standards for fecal coliform (South Carolina's water quality standard for fecal coliform bacteria allows for no more than 10 percent exceedances of the 400 cfu/100 mL instantaneous criterion). Monitoring will continue at all three stations to ensure that standards are maintained.

In addition to the obvious water quality benefits, the Coneross Creek and Beaverdam Creek project has resulted in many physical, economic, and social benefits to project participants. Agricultural producers, for example, discovered that implementing the BMPs improved forage management and utilization, distributed livestock grazing patterns more evenly, and increased revenue from the addition of product lines such as compost.

Waste stacking sheds, like this one, reduce the amount of fecal coliform that washes away after a rain event.

Partners and Funding

The project was a partnership between SCDHEC, Clemson University, USDA Natural Resources Conservation Service, Oconee County Soil and Water Conservation District, and the Oconee County Cattlemen's Association.

The project used just over $583,000 in federal 319 funds and $100,000 in EQIP, which included an additional match of $417,000. The total cost for this project was over $1,100,000.

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Streambank Restoration and Cattle Exclusion Reduce Siltation and Improve Water Quality

Waterbody Improved

Agricultural practices and land development in the Arrington Creek watershed were contributing to silt runoff that was degrading the water quality of the creek. The waterbody was listed as impaired on Tennessee's 2002 303(d) list due to siltation from agriculture and land development. Best management practices (BMPs) implemented in the watershed successfully improved the water quality of Arrington Creek and allowed for its removal from the impaired list in 2004.

Problem

Arrington Creek is located in Williamson County in central Tennessee. It is in the Harpeth River watershed, Ecoregion 71i. A 24.6-mile segment of Arrington Creek was listed as impaired on the state's 2002 303(d) list for siltation. Arrington Creek was only partially supporting criteria for its designated use classification (fish and aquatic life). The state identified agricultural practices and land development as the primary sources of silt entering the waterbody. A siltation and habitat alteration total maximum daily load (TMDL) was previously developed for this watershed and approved by EPA in 2002.

Project Highlights

Eight BMPs were implemented along Paige Branch, a tributary to Arrington Creek, between 1999 and 2003. The installment of exclusion fencing and an alternative watering facility prevented livestock from entering the stream, thereby reducing the trampling of streambanks. Other BMPs implemented include pasture and hay planting along critical areas, reinforcement of heavy use areas, streambank protection, and planting riparian buffers (Figure 1). These management practices helped reduce the amount of silt and runoff entering the waterway.

Results

The BMPs implemented along Paige Branch, a tributary to Arrington Creek, have helped reduce the level of siltation entering the waterbody and allowed it to meet its designated water quality standards such that there were no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks. In addition the Branch was found to be no longer detrimental to fish and aquatic life. This stream was reassessed in 2002 by the Tennessee Department of Environment and Conservation (TDEC). Using EPA's rapid bioassessment protocol III (RBPIII), state biologists calculated a biological reconnaissance (biorecon) score for Arrington Creek, which is used to measure a compliance with the state water quality standard for siltation. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1–15. A score less than

5 is regarded as very poor. A score over 10 is considered good. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon results for Arrington Creek indicated 10 EPT families, 7 intolerant, and 25 total families. The stream received a score of 15 out of 15, indicating that it is now fully supporting fish and aquatic life. The stream got a habitat score of 115, which is similar to the established habitat goal for this region. The stream has improved since last assessed and therefore Arrington Creek was removed from Tennessee's list of impaired waters in 2004.

Partners and Funding

The Williamson County Soil Conservation District and the Harpeth River Watershed Association helped implement the BMPs with $12,500 of section 319 direct and matched funding. An additional $55,627.81 was contributed by the Tennessee Agricultural Resources Conservation Fund and matching funds.

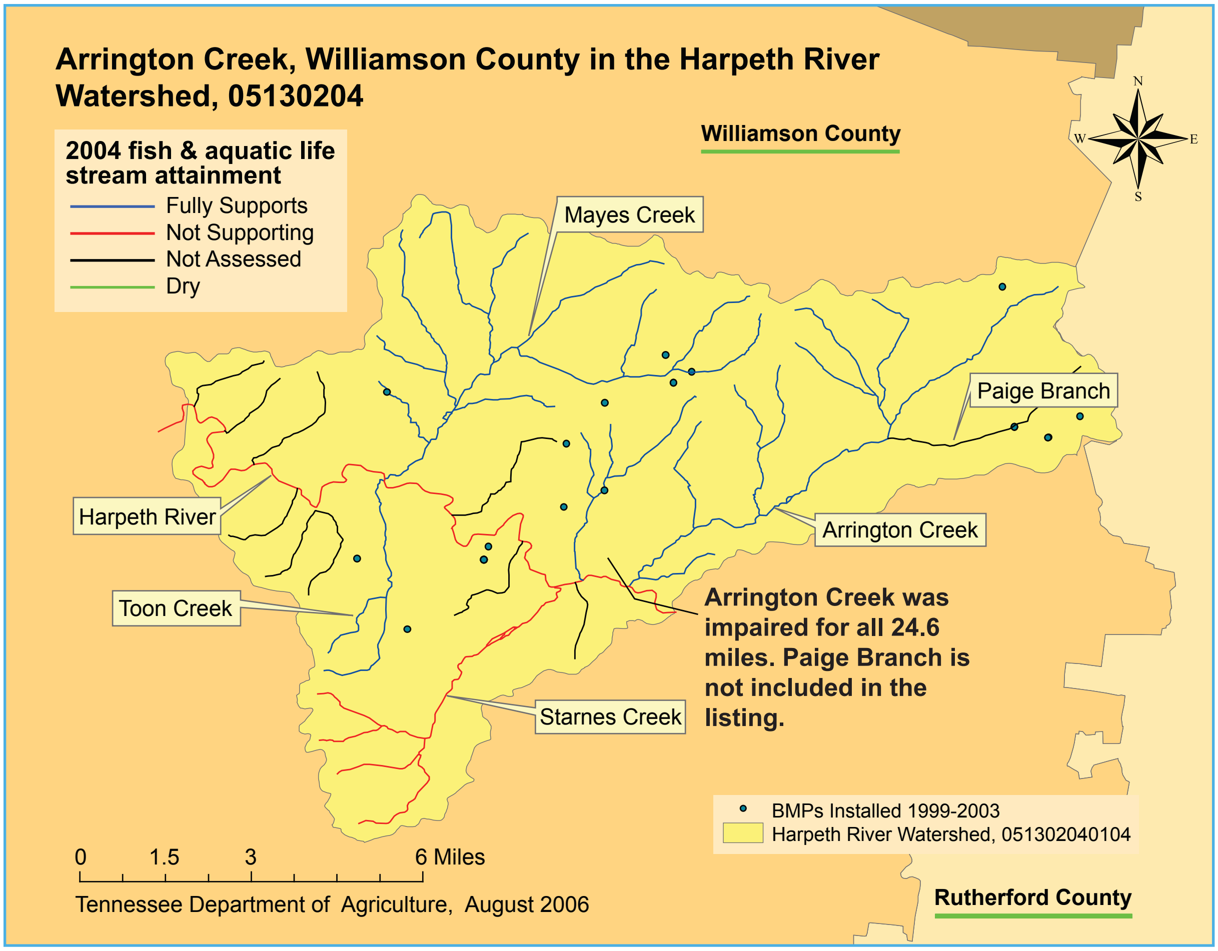

Figure 1. BMPs implemented in the Harpeth River watershed.

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Best Management Practices Reduce Siltation and Contaminated Runoff

Waterbody Improved Runoff from livestock operations and unrestricted grazing was contributing high levels of sediment and nutrients to Blue Spring Creek in Coffee County, Tennessee. Education and the introduction of best management practices (BMPs), including fencing, water facilities for cattle, and waste management systems, have helped to eliminate existing water quality problems, allowing the creek to be removed from Tennessee's 303(d) list.

Problem

Beef production is a major enterprise in Coffee County, Tennessee, and livestock are raised throughout the region to supply this industry. Poor nutrient management plans and grazing practices resulted in runoff that contained sediment and nutrients entering the stream untreated. Based on the results of a macroinvertebrate sampling and habitat assessment that demonstrated values below expectations for streams in the Eastern Highland Rim ecoregion, the Blue Spring Creek was listed on Tennessee's 2002 303(d) list as having "other habitat alterations" due to nonirrigated crop production.

Project Highlights

Educational efforts have raised awareness about the water quality problems associated with unrestricted livestock grazing. Farmers have been willing to help improve water quality by installing BMPs on their land. Exclusion fencing was used to keep livestock out of natural water sources and off streambanks. As a result, native vegetation has returned to streambank areas, providing habitat for wildlife and serving as a natural filter strip.

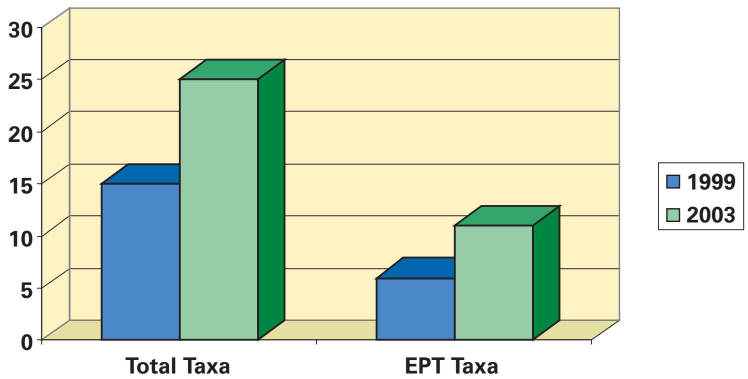
Alternative watering systems provide livestock with water in areas with no stream access. Frost-free water tanks have been particularly successful in providing better water quality for humans, livestock, aquatic plants, and animals. The soil in heavy-use areas surrounding alternative water ponds is stabilized with geotextile material to further prevent erosion.

Animal waste management systems, such as holding ponds, allow for proper waste disposal. Such systems take care of contaminated runoff, as well as wash water and flush water from dairy or swine operations.

Pasture seeding with a mix of fescue and white clover, in combination with a nutrient management plan, provided effective erosion control on area farms.

Results

By 2003 biological integrity and habitat at Blue Spring Creek had improved, as measured by the higher diversity and types of macroinvertebrates such as insects, crayfish, snails, and clams—indicators of good water quality. Almost twice as many EPT families (a category of insects used to measure water quality) were present in 2003 (11 EPT) than in 1999 (6 EPT), and 25 different taxa were collected in 2003 as compared to 15 different taxa found in 1999. Eight of these families are intolerant of pollution. These metric values represent the highest score possible (15) out of a family-level biological reconnaissance (biorecon) index that considers scores from 11 to 15 indicative of a non-impaired biological community. The habitat assessment score had improved from 114 in 1999, which is considered inadequate in the ecoregion, to a score of 136—well above the target habitat score of 123, which indicates a healthy biological population in the ecoregion. As a result, Blue Spring Creek was removed from Tennessee's 303(d) list in 2004.



Number of families in the pollution-sensitive group EPT found at Blue Spring Creek in Coffee County between 1999 and 2003.

Partners and Funding

This project included support from the U.S. Department of Agriculture Natural Resources Conservation Service and the Coffee County Soil Conservation District, which designed and approved the animal waste management systems. The project costs totaled $110,219, including funding through the Agricultural Resources Conservation Fund (ARCF) and $8,733 of Clean Water Act section 319 cost-share funding, which was used to cover the costs of exclusion fencing, alternative water facilities, and pasture seeding.

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Reducing the Impacts of Cattle Grazing Improved Water Quality

Waterbody Improved

Polluted runoff from pasture-grazing cattle and erosion of sensitive pastureland degraded the water quality of Cripple Creek. This led to the listing of a 7.7-mile segment of Cripple Creek as impaired in 2002. Several best management practices (BMPs) were implemented, including pasture renovation, grassed waterways, and a livestock watering facility. This resulted in water quality improvements of the 7.7-mile segment of Cripple Creek and its removal from the 2004 list of impaired waters.

Problem

Cripple Creek is located in the East Stones River Watershed in Rutherford County, Ecoregion 71i. The creek was listed as impaired on the 2002 303(d) list for siltation, which is a common pollutant of surface waters. Siltation can cause significant economic impacts such as increased water treatment costs, loss of storage capacity in reservoirs, direct impacts to navigation, and the increased possibility of flooding. The state identified pasture grazing as the major source of impairment. A siltation total maximum daily load (TMDL) was established in 2002 by Tennessee's Department of Environment and Conservation for Cripple Creek.

Cripple Creek was listed for not meeting the state water quality standard for siltation in order to fully support its designated beneficial use of fish and aquatic life. The standard states that there shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life.

Project Highlights

Fourteen BMPs were implemented by the Rutherford County Soil Conservation District from 1999 to 2003 in the East Stones Fork River Watershed. Over 157 acres were renovated as a result of replanting pasture lands and the implementation of grassed waterways (Figure 1). Grassed waterways are graded natural structures that improve water quality by conveying runoff without causing flooding or erosion, and help to reduce gully erosion. In addition, an alternative livestock watering facility was implemented to provide accessible water for livestock. The watering facility has several positive effects: 1) it protects and enhances vegetative cover through proper distribution of grazing, 2) it provides erosion control through better grassland management, and 3) it protects Cripple Creek and other water supplies from contamination by providing livestock with alternative access to water.

Results

Using EPA's rapid bioassessment protocol III (RBPIII), state biologists calculated a biological reconnaissance (biorecon) score for Cripple Creek, which is used to measure compliance with the state water quality standard for siltation. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1 – 15. A score less than 5 is regarded as very poor. A score over 10 is considered good. The principal metrics used

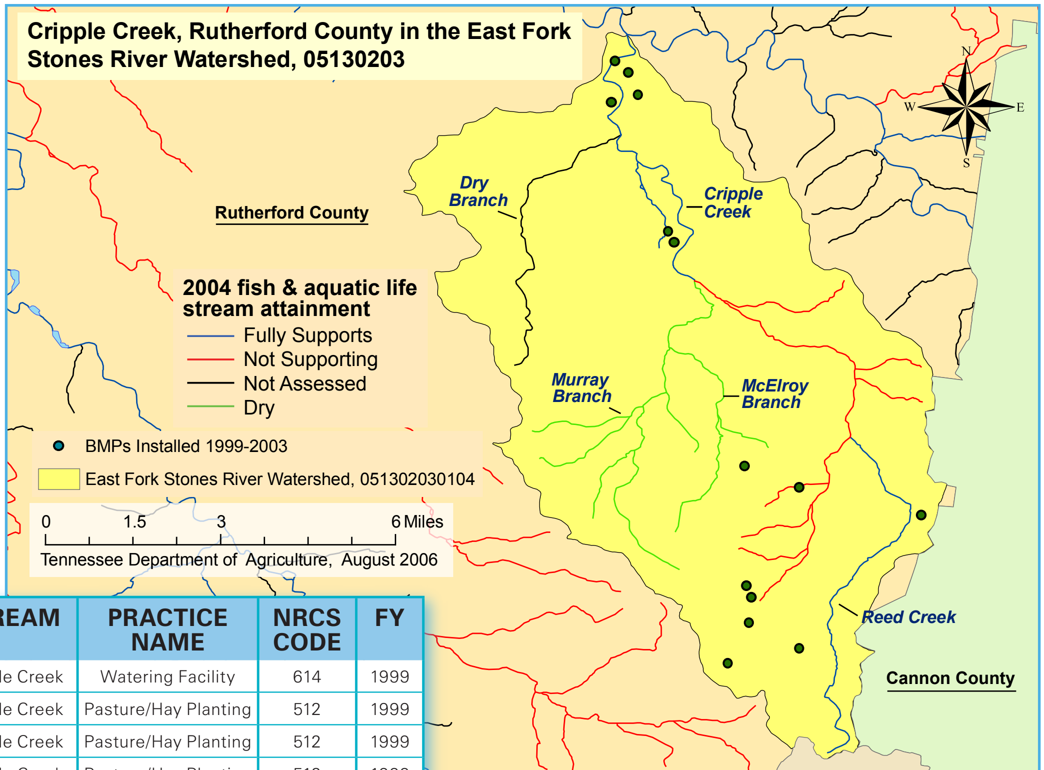

Figure 1. Map of Implemented BMPs. Table (left) is a list of implemented BMPs.

ID	COUNTY	HUC	STREAM	PRACTICE NAME	NRCS CODE	FY
5746	Rutherford	5130203	Cripple Creek	Watering Facility	614	1999
5760	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	1999
5761	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	1999
5762	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	1999
5764	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2000
5792	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2001
5795	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2001
5800	Rutherford	5130203	Cripple Creek	Grassed Waterway	412	2001
5805	Rutherford	5130203	Cripple Creek	Grassed Waterway	412	2002
5812	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2002
7599	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2003
7600	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	2003
5748	Rutherford	5130203	Cripple Creek	Pasture/Hay Planting	512	1999
5825	Rutherford	5130203	Cripple Creek	Grassed Waterway	412	2002

are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon results for Cripple Creek indicated 8 EPT families, 3 pollutant intolerant taxa, and 20 total families. Using the scoring system for biorecons, this stream scored a 15. The stream got a habitat score of 146, which is better than the established habitat goal for this ecoregion. Water quality standards were also met at a chemical station located on the creek at mile 0.4, resulting in the delisting of Cripple Creek from the 2004 303(d) list.

Partners and Funding

The Rutherford County Soil Conservation District helped implement the BMPs with section 319 funding. $7,143 of section 319 funding was matched with $3,146.86 in local contributions. The Tennessee Agricultural Resources Conservation Fund (ARCF) provided an additional $9,341.02, $3,699.22 of which was locally matched.

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Best Management Practices Reduce Pathogens in Cane Creek

Waterbody Improved Cane Creek, in McMinn County, Tennessee, was contaminated by pathogens due to urban runoff/storm sewers and pasture grazing. Pathogen inputs to the creek were reduced by stabilizing erosion-prone areas near animal feeding operations and relocating the discharge point for the city of Etowah's stormwater discharge. As a result, Cane Creek was removed from Tennessee's 303(d) list.

Problem

Effluent from the city of Etowah's sewage treatment plant and runoff from cattle and poultry production areas contributed to the high levels of pathogens in Cane Creek. Of 12 fecal coliform samples collected between 1993 and 1996, 4 samples exceeded the fecal coliform criterion of 1,000 colonies per 100 mL. In 2002 Cane Creek was added to the state's 303(d) list as impaired by pathogens due to urban runoff/storm sewers and pasture grazing in the watershed.

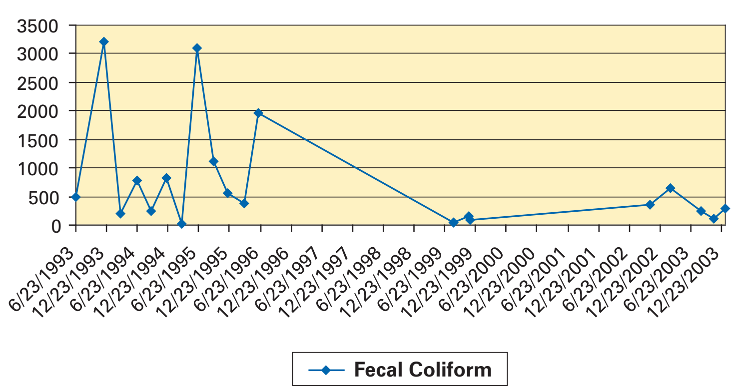
Project Highlights

Poultry and cattle farmers in the Cane Creek watershed installed conservation treatments known as heavy-use areas (HUAs). HUAs usually use geotextile material and gravel to stabilize soil in areas containing large concentrations of animals, thereby preventing soil erosion and improving water quality. Nine HUAs were installed on a large (400-acre) farm in the Cane Creek watershed and three more were installed on a smaller farm according to Natural Resources Conservation Service design standards. In addition to the HUAs, fencing was installed to exclude cattle from streams and stream crossing to minimize erosion where crossings are necessary. Trees were planted in critical areas to decrease soil erosion and provide additional habitat.

The city of Etowah's sewage treatment plant moved its stormwater discharge to another stream. The city had historically discharged to Cane Creek, which was previously assessed as impaired by pathogens on the basis of sampling results from the 1990s.

Results

By 2004 pathogen levels had reached acceptable levels as a result of the best management practices (BMPs) implemented throughout the watershed. Of the nine fecal coliform samples collected between 1999 and 2004, only one sample exceeded the *E. coli* criterion of 941 colonies per 100 mL. Although the fecal coliform criterion had been replaced by *E. coli*,



Number of fecal coliform colonies per 100 mL at Cane Creek River Mile 1.5 in McMinn County 1993–2004. Data collected by Water Pollution Control, Tennessee Department of Environmental Conservation.

levels were reduced to 640 colonies or fewer, which is below the criterion of 1,000 colonies per 100 mL that was used to list the stream. As a result, Cane Creek was removed from Tennessee's 303(d) list in 2004.

Partners and Funding

The U.S. Department of Agriculture Natural Resources Conservation Service and the McMinn County Soil Conservation District helped design and implement many of the BMPs. The project cost a total of $36,550, funded through the Agricultural Resources Conservation Fund (ARCF) and $7,576 of Clean Water Act section 319 funding that was used for critical area plantings, HUAs, and a stream crossing.

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Office of Water
Washington, DC

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Bedford County Improves Water Quality Through Waste Management Systems

Waterbody Improved Polluted runoff from pasture grazing caused nutrients and sediment to enter into Fall Creek, which led to the listing of a 11.4-mile segment of Fall Creek as impaired in 2002 and 2004. Using section 319 funding, the Bedford County Soil Conservation District installed two major Waste Management Systems on tributaries to Fall Creek in 1999. This resulted in water quality improvements of the 11.4-mile segment of Fall Creek and its removal from the 2006 303(d) list of impaired waters.

Problem

Fall Creek is located in the Duck River watershed in Bedford County. This specific segment is impaired from Duck River to the headwaters in EcoRegion 71I. Fall Creek was listed as impaired on the 2002 and 2004 303(d) lists due to nutrients, loss of biological integrity, and habitat alterations from pasture grazing. Fall Creek has many designated use classifications including fish and aquatic life, recreation, livestock watering and wildlife, and irrigation. It was listed as impaired for not fully supporting the fish and aquatic life and recreation beneficial uses due to siltation altering the habitat and excess nutrients resulting in low dissolved oxygen.

Two total maximum daily loads (TMDLs) were established for Fall Creek in 2006 by the Tennessee Department of Environmental Conservation for low dissolved oxygen caused by excess nutrients and habitat alteration caused by siltation.

Project Highlights

The local Soil Conservation District offices in Bedford County administered the Clean Water Act section 319 funding to allocate funding assistance. Using a combination of 319 funding as well as state funds through the Agricultural Resources Conservation Fund (ARCF) they installed Waste Management Systems on tributaries to Fall Creek in 1999. These systems included two litter storage units for chickens with the capacity to store and compost 199 acres on Parch Corn Creek, which runs into Fall Creek (Figure 1).

The installation of these poultry composters and animal waste systems minimized the potential for contamination of streams. The waste facilities also reduce the pollution potential of organic agricultural wastes to surface and ground water.

Results

The Tennessee Macroinvertebrate Community Assessment is used to calculate the Tennessee Stream Condition Index (TSCI), which is a measure of biological health of an aquatic system. This index is used by the state in determining a waterbody's compliance to state water quality standards for the beneficial

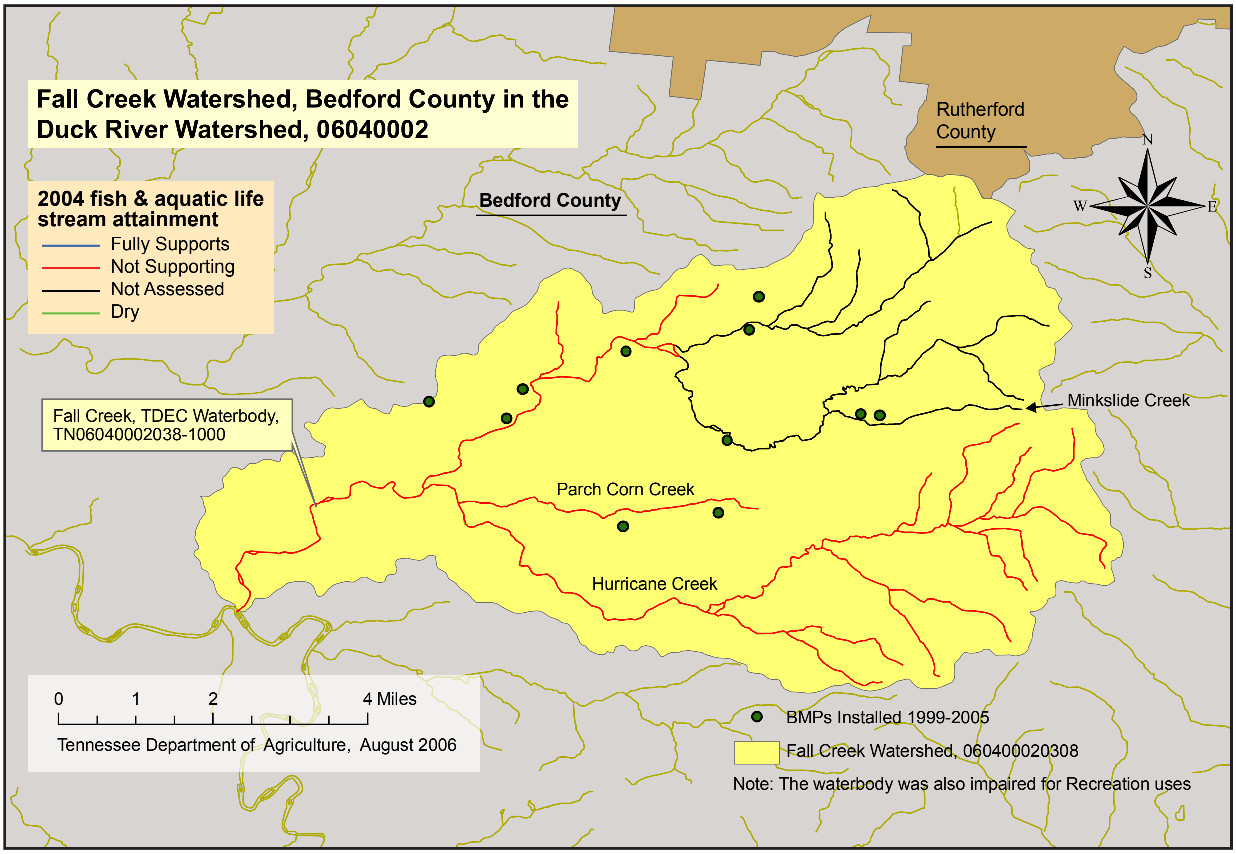

Figure 1. Locations of BMPs installed from 1999–2005

use of fish and aquatic life. The TSCI was used to compare subregions and determine a score, for a total possible score of 42.

Chemical and biological stations were established on this stream in 2004. While the stream was found to still be impacted by pathogens and will remain listed on that basis, Rapid Bioassessment Protocol (RBPIII) sampling at two different locations documented TSCI scores of 36 and 32, which met Tennessee's biological integrity goals.

Therefore Fall Creek has been removed from the 303(d) list in 2006 for nutrients, biological loss due to siltation, and habitat alteration.

Partners and Funding

Fall Creek has benefited from a total of $13,861.47 provided through cost-share from section 319 grant pool projects. In addition, $94,747.00 was provided by a Tennessee State ARCF grant and local match.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Tennessee

Livestock Management Restores Waterbody

Waterbody Improved Polluted runoff from pasture-grazing cattle caused abnormal *Escherichia coli* counts in Hinds Creek, which led to 8.9 miles of the stream being listed on the state's 303(d) list in 2002 and 2004.

Using section 319 funding, farmers installed a number of BMPs on pastureland adjoining the creek. The practices included pasture and hay planting, fencing, streambank protection, and separate watering structures. The farmers' action allowed the Hinds Creek segment to be removed from the 2006 303(d) list.

Problem

Hinds Creek is in the Lower Clinch watershed in eastern Tennessee, a primarily rural watershed with approximately 75 percent forest and 15 percent agriculture. Hinds Creek was listed as impaired on the state's 2002 and 2004 303(d) lists due to high *E. coli* colony counts and in-stream concentrations. Polluted runoff carrying fecal matter and pathogens from pasture-grazing livestock was the source of this pollution.

Hinds Creek has multiple designated use classifications, including fish and aquatic life, livestock watering and wildlife, irrigation, and recreation. Monitoring along Hinds Creek between 1999 and 2004 found that the creek was fully supporting all designated uses except recreation. Analysis results for individual samples collected by the state were in violation of the state-established water quality criteria for *E. coli*. The Tennessee water quality standards state that the concentration of the *E. coli* group in any individual sample must not exceed either (a) 487 cfu/100 mL for lakes, reservoirs, State Scenic Rivers, or Tier II or III waterbodies or (b) 941 cfu/100 mL for all other waterbodies. Hinds Creek is in the latter category.

A TMDL for pathogens in the Lower Clinch watershed, established in 2005 by the Tennessee Department of Environment and Conservation, specified a 49.5 percent reduction in pathogen loading into Hinds Creek.

Before the project, high flows during storm events caused increased erosion.

Project Highlights

Local Soil and Water Conservation District offices in Anderson and Union counties administered the CWA section 319 funding to allocate funding assistance to local landowners. Using a combination of 319 funding and state funds from the Agricultural Resources Conservation Fund (ARCF), they worked with local landowners to promote and install management practices and structures that would reduce pathogen runoff into Hinds Creek and improve landowners' operations.

Installed fencing with stream buffer on left.

The BMPs installed included (1) pasture seeding and riparian zone planting along Hinds Creek and tributaries; (2) stabilization of heavy-use areas using gravel and geotextile fabric; (3) installation of alternative watering facilities, such as tanks, troughs, and ponds fed by pipelines to keep livestock out of streams; and (4) alternative access roads to help combat further erosion.

Pasture and riparian critical areas were seeded with a selection of grasses that were acceptable to livestock and beneficial for proper soil drainage in the area. Problem weed and thistle species were replaced with balanced and native foliage to improve water quality, conserve soil, and increase carbon sequestration.

Local Soil and Water Conservation District agents advised landowners on the technical design and specifications of the BMPs, and they provided oversight and expertise during the installation process. Landowners participated voluntarily, partially providing labor and funds for the BMPs. The BMPs were installed beginning in 2000, and continue to be installed to help continue to meet the load reduction allocations in the 2005 TMDL.

The Hinds Creek Watershed Partnership, a group composed of federal, state, and local partners, is focused on improving water quality and community awareness of water quality issues in Hinds Creek. The Partnership is part of a cooperative water quality monitoring project with the Tennessee Department of Environment and Conservation and the Tennessee Valley Authority that aims to produce comprehensive watershed assessments. Gathering information regarding the health of the watershed will help in prioritizing areas of work.

Results

Recent monitoring in Hinds Creek showed *E.coli* values below the individual sample standard of 941 cfu/mL. Hinds Creek is no longer considered impaired for any of the four designated uses, including recreation. Therefore, the 8.9 total miles previously listed as impaired were not included on the 2006 303(d) list.

Partners and Funding

Since 2001 Hinds Creek has benefited from $39,246.41 of Clean Water Act section 319 funding (including additional matching funds, a total of $57,695.17 was spent). In addition, $30,840.35 was provided by the Tennessee ARCF. Key partners in this effort include the Anderson County and Union County Soil Conservation Districts, whose agents provided technical expertise and labor hours. Landowners in the Lower Clinch watershed contributed in-kind labor hours and some funding.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Tennessee

Agricultural BMPs Reduce the Impact of Cattle Grazing and Improve Quality of Creek's Habitat

Waterbody Improved A portion of Lick Creek located in Marshall and Rutherford Counties was listed as impaired due to *Escherichia coli (E. coli)* and habitat alterations on the 2004 303(d) list. Using section 319 and state funding, the Marshall County Soil Conservation District installed Heavy Use Area (HUA) best management practices (BMPs), including exclusion fencing, animal waste lagoons, and planted hay and pasture grasses along Lick Creek. These nonpoint source pollution control efforts allowed this 8.8-mile segment of Lick Creek to be removed from the 2006 303(d) list for habitat alterations.

Problem

Lick Creek is located within the Duck River Watershed in Marshall and Rutherford Counties, Ecoregion 71i. The source of the pollutants was identified as livestock grazing in pasturelands where cattle had direct access to the stream, which resulted in the degradation of habitat through the trampling of streambanks and the input of pathogens.

Lick Creek was listed in 2004 for not meeting water quality standards for its designated beneficial uses due to elevated *E. coli* values and habitat alterations as a result of unrestricted cattle access to the creek. Lick Creek Marshall has multiple designated use classifications, including fish and aquatic life, livestock watering and wildlife, irrigation, and recreation. Lick Creek Marshall was listed for not meeting standards to fully support two of its four designated beneficial uses: fish and aquatic life, and recreation.

Tennessee's water quality standards for recreation state that the concentration of the *E. coli* group in any individual sample shall not exceed either (a) 487 cfu/100ml for lakes, reservoirs, State Scenic Rivers, or Tier II or III waterbodies or (b) 941 cfu/100ml for all other waterbodies. Lick Creek Marshall falls into the latter category.

E. coli and siltation total maximum daily loads (TMDLs) were established in 2006 by the Tennessee Department of the Environment and Conservation (TDEC) for Lick Creek in Marshall County.

Project Highlights

Funding from the Agricultural Resources Conservation Fund (ARCF) was used to plant 25 acres of hay and pasture grasses along this segment of Lick Creek and its tributary Plum Branch, to filter pollutants, reduce erosion, and stabilize the stream banks (Figure 1). In addition, exclusion fencing and an animal waste lagoon were installed along the stream to reduce the direct input of pathogens such as *E.coli*.

Results

The Tennessee Macroinvertebrate Community Assessment is used to calculate the Tennessee Stream Condition Index (TSCI), which is a measure of biological health of an aquatic system. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. This index is used by the state to determine a waterbody's compliance to state water quality standards for the beneficial use of fish and aquatic life. The TSCI was used to compare subregions and determine a score, for a total possible score of 42. Using EPA's rapid biological protocol III sampling at station 1.8 (Mt. Vernon Road), state biologists found six EPT species and a total diversity of 23 different types of macroinvertebrates. The TSCI score for the station was 36, which is greater than the regional goal of 32 and within the "very good" range. Since biological integrity appears to be no longer impaired, the stream was delisted for habitat alteration and removed from the 2006 303(d) list. However, this segment of Lick Creek remains on the list for *E.coli*.

Partners and Funding

Lick Creek Marshall has benefited from \$536.40 provided through cost-share from section 319 grant pool projects. In addition, \$1608.60 was provided from the State's ARCF.

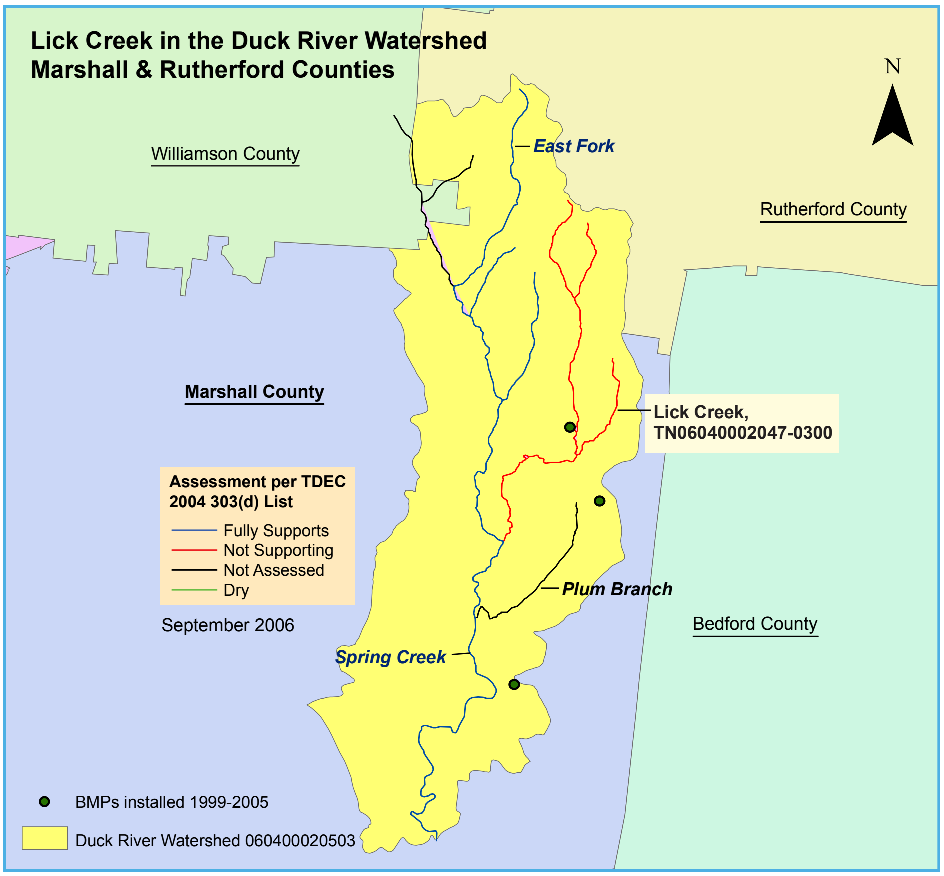

Figure 1. Map of BMPs installed.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY

Tennessee

Revegetation and Streambank Restoration Reduce Siltation and Improve Water Quality

Waterbody Improved Polluted runoff from non-irrigated crop production resulted in excess sediment in Lick Creek. This resulted in a loss of biological integrity and physical substrate habitat alterations due to siltation, which led to the listing of a 20-mile segment of Lick Creek as impaired in 2002 and 2004. Using section 319 funding, McNairy County Soil Conservation District planted pasture and hay to revegetate the pasture and protect the streambank. These efforts resulted in the removal of the impaired 20-mile segment of Lick Creek from the 2006 303(d) list of impaired waters.

Problem

This 20-mile segment of Lick Creek extends from Snake Creek to the headwaters in the Snake Creek Watershed, McNairy County in Ecoregion 65e. Lick Creek was listed as impaired due to siltation and habitat alteration, resulting in a loss of biological integrity. Polluted runoff carrying sediment from non-irrigated crop production was the source of this pollution and prevented Lick Creek from meeting state water quality standards to fully support its designated beneficial use for fish and aquatic life. The standard states that there shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life.

Project Highlights

The local Soil and Water Conservation District office in McNairy County administered the funding for this project. Using a combination of section 319 matched funding and state funds through the Agricultural Resources Conservation Fund (ARCF), the Conservation District offices worked with local landowners to plant pasture and hay to act as a covercrop and reduce erosion of non-irrigated croplands, as well as provide streambank protection to reduce siltation and improve the habitat of Lick Creek (Figure 1).

Results

Lick Creek was reassessed in 2004 using the biological reconnaissance (biorecon) survey, which is used to measure water quality compliance for the beneficial use of fish and aquatic life. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1 – 15. A score less than 5 is regarded as very poor. A score over 10 is considered good. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon results for Lick Creek indicated 4 EPT genera, 2 pollutant intolerant genera, and 15 total genera.

The resulting score of 11 for this subecoregion (65e) is within the “non-impaired” range. In addition, Lick Creek met the narrative criteria for turbidity and total suspended solids of no observed presence of solids, floating materials and deposits of such a size or character that may be detrimental to fish and aquatic life. Therefore, 20 total previously-impaired miles were delisted from the 2006 303(d) list.

Partners and Funding

Since 2004, Lick Creek has benefited from $7,805.97 provided through cost-share from section 319 Grant Pool Projects. In addition, $3,121.71 was provided by the Tennessee State ARCF. Additional matching funds (state and local) amounted to a total of $10,237.03. Another key partner in this effort was the Chickasaw-Shiloh Resource Conservation and Development Council.

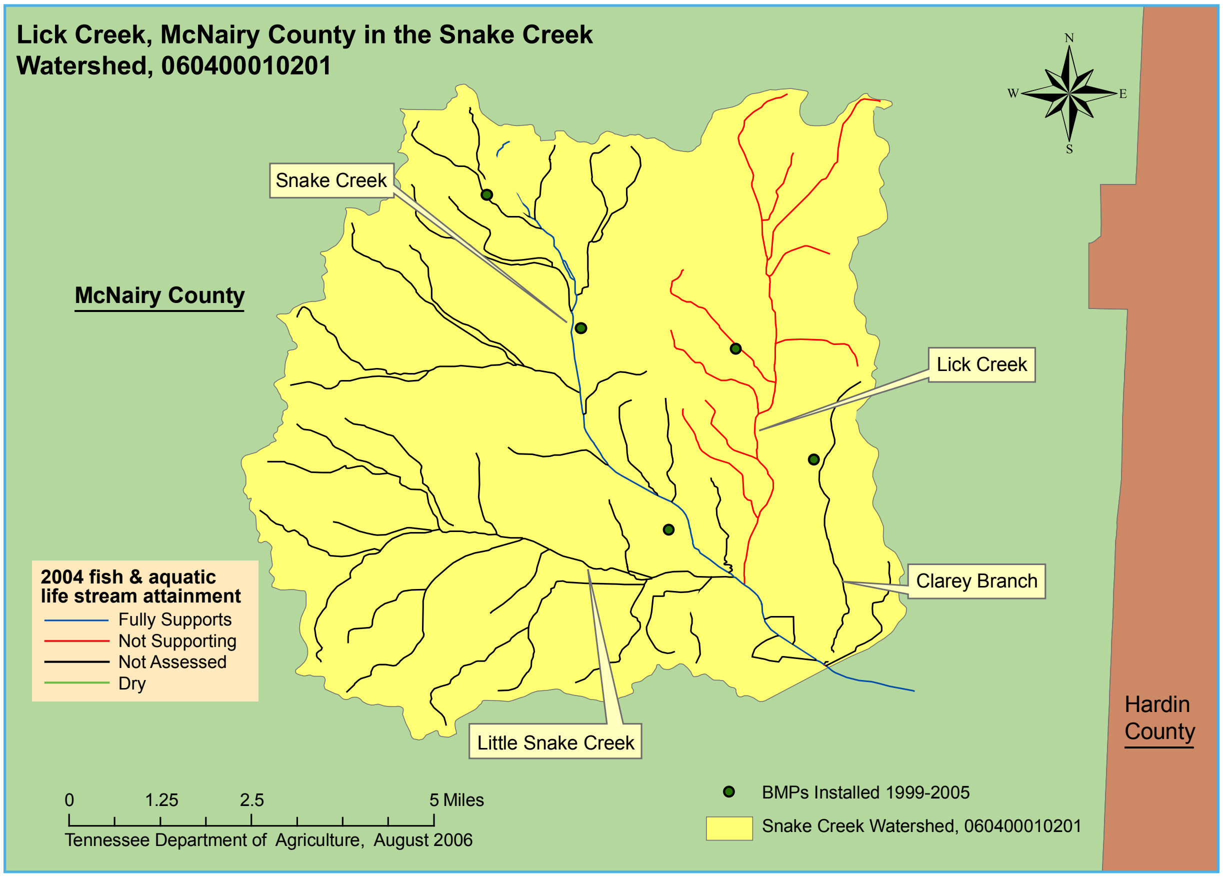

Figure 1. Location of Implemented Best Management Practices (BMPs)

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New Grazing Practices Minimize Impacts on Little Shoal Creek

Waterbody Improved The Little Shoal Creek in south-central Tennessee was clogged with silt from pasture grazing and other agricultural activities. Pasture management practices were successfully implemented to reduce erosion and pollution transport to the creek, allowing the creek to be removed from Tennessee's 303(d) list.

Problem

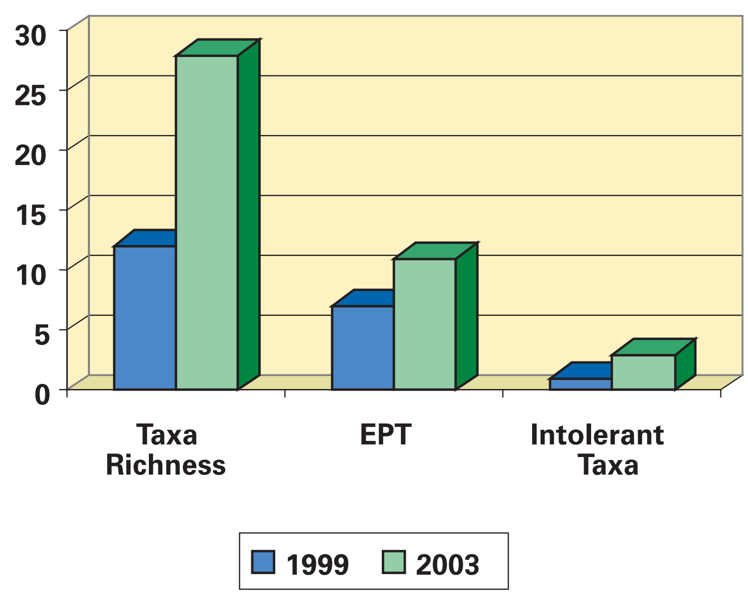
Overgrazing and poor pasture management caused heavy erosion in Little Shoal Creek in Lawrence County, Tennessee. A macroinvertebrate sample collected in 1999 demonstrated values below expectations for biological communities in the Western Highland Rim ecoregion. Based on these results, Little Shoal Creek was added to the state's 303(d) list in 2002 as impaired due to siltation from pasture grazing.

Project Highlights

To combat erosion, BMPs were implemented on the land surrounding Little Shoal Creek and its two tributaries, Crossfield Branch and Fourmile Hollow. To control and minimize the impacts of agriculture, farm conservation practices, including conservation tillage, cropland conversion, pasture renovation, and hay planting, were implemented. In addition, red clover and other legumes were introduced to improve ground cover in bare areas. Installing grassed waterways on 150 acres of farmland near streams and tributaries has helped to prevent gully erosion and reduce pollutants carried by runoff water to streams. Farmers also use the grassed areas periodically for grazing livestock.

Results

The increased ground cover and installation of grassed waterways have resulted in less soil erosion and siltation in the stream, reducing the amount of pollutants entering the streams and improving water quality. Another macroinvertebrate sample collected in 2003 demonstrated that taxa richness had more than doubled to 28, as compared to only 12 in 1999—an indicator of good water quality as measured by the higher diversity and types of organisms living in the stream. These metric values are within the guidelines for the ecoregion and would score 13 on the genus-level



Macroinvertebrate taxa groups found in 1999 and 2003 from Little Shoal Creek in Lawrence County.

biological reconnaissance (biorecon) index, which considers scores from 11 to 15 indicative of a non-impaired biological community. As a result of the restoration efforts, Little Shoal Creek was removed from Tennessee's 303(d) list in 2004.

Partners and Funding

The U.S. Department of Agriculture Natural Resources Conservation Service and the Lawrence County Soil Conservation District spearheaded the effort to design and implement many of the BMPs. The project cost a total of $44,800, including funding from the Agricultural Resources Conservation Fund (ARCF) and $10,000 of Clean Water Act section 319 funding, which was used for pasture/hay planting.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Tennessee

Heavy Use Area BMPs Reduce Erosion and Improve Water Quality

Waterbody Improved

Polluted runoff from pasture grazing livestock and the removal of riparian vegetation caused siltation and habitat alterations in Rock Springs Branch. This led to the listing of an 8.1-mile segment of Rock Springs Branch as impaired in 2002. Using section 319 funding, Putnam, Smith, and DeKalb County Soil Conservation Districts installed heavy use area (HUA) best management practices (BMPs) on Bates Branch, a tributary to Rock Springs Branch. Fifteen acres of HUA were implemented to help stabilize an area that cattle trod through, helping to improve water quality and prevent soil erosion. This resulted in the removal of the Rock Springs Branch segment from the 2004 303(d) list of impaired waters.

Problem

Rock Springs Branch is located in Putnam County within the Caney Fork River Watershed, and consists primarily of rural/urban land uses with approximately 75% forest and 21% agriculture. The Branch was listed as impaired on the state's 2002 303(d) list due to siltation and other habitat alterations. Polluted runoff carrying sediment from grazing fields was the source of this pollution, which impaired the Branch's ability to meet Tennessee's water quality standards to fully support its designated use classifications for fish and aquatic life. The standard states that there shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits, or sludge banks of such size or character that may be detrimental to fish and aquatic life, and the instream habitat within each subecoregion shall be generally similar to that found at reference streams.

A siltation total maximum daily load (TMDL) was established for the Rock Springs Branch in 2005 by the Tennessee Department of Environment and Conservation.

Project Highlights

Local Soil and Water Conservation District offices in Putman, Smith, and De Kalb counties allocated funding assistance to farmers of pasture grazing lands through a grant from the Tennessee State Agricultural Resources Conservation Fund (ARCF). Using a combination of matched 319 funding as well as state funds, they worked with local landowners to promote and install management practices and structures that would both reduce runoff into Rock Springs Branch and improve their operations.

Heavy use area BMPs were installed on two different farms along both Rock Springs and Bates Branch to reduce soil erosion (Figure 1).

Results

Rock Springs Branch was found to have greatly improved water quality due to the installed BMPs. Using EPA's rapid bioassessment protocol III (RBPIII), state biologists calculated a biological reconnaissance score (biorecon) for the Branch, which is used as a measure of compliance with water quality standards for the beneficial use of fish and aquatic life. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1 to 15.

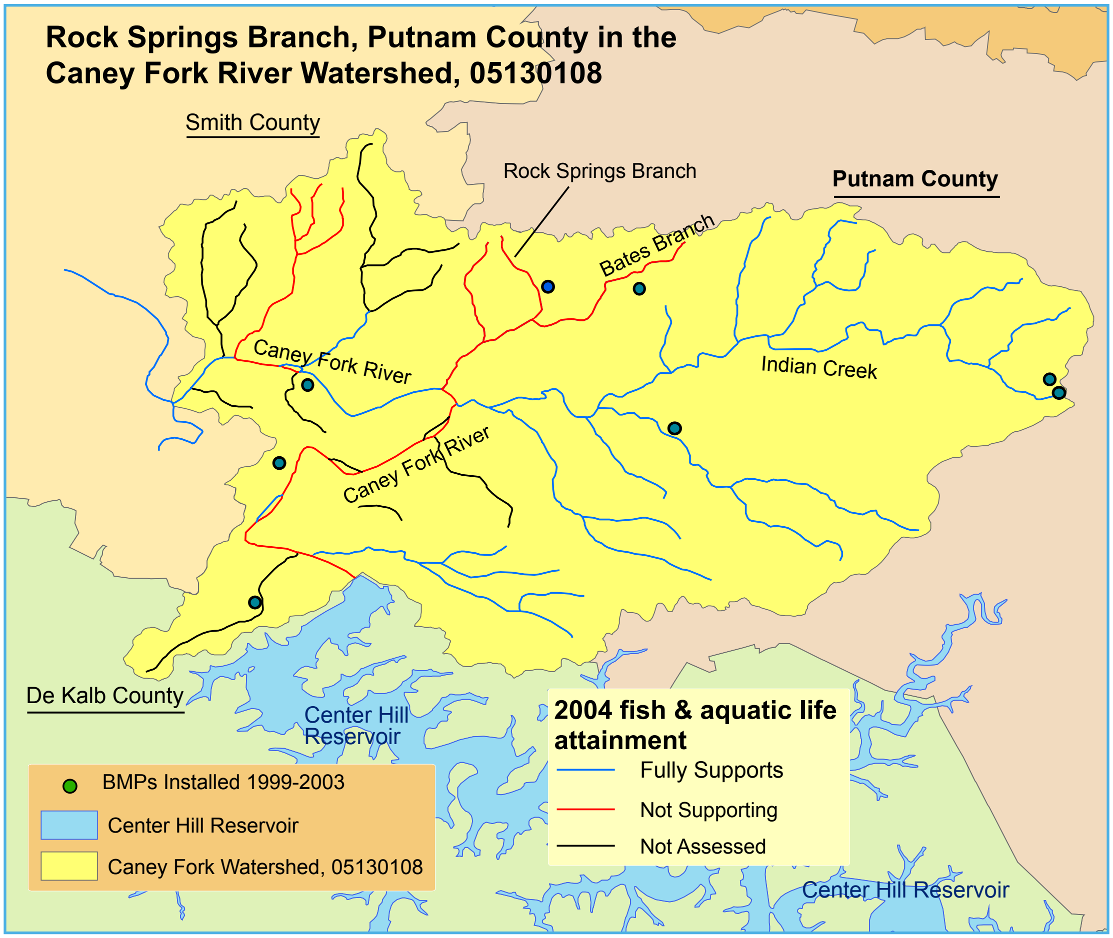

Figure 1. Location of Implemented BMPs

A score of less than 5 is regarded as very poor. A score of more than 10 is considered good. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon score for Rock Springs Branch indicated 12 EPT families, six pollutant intolerant species, and a total of 29 macroinvertebrate families. Using the Division scoring system for biorecons, this stream scored a 15. The stream got a habitat score of 137, which is better than the established habitat goal for this region. These results indicated the improved water quality and ability to fully support fish and aquatic life. Therefore, the 8.1-mile segment of Rock Spring Branch was delisted from the 2004 303(d) list of impaired waters.

Partners and Funding

Since 2002, Rock Springs Branch has benefited from $57,378.00 provided through cost-share from section 319 grant pool projects. In addition, the State ARCF provided $36,986.72. Key partners in this effort include the Putnam, Smith, and De Kalb County Soil Conservation Districts.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Tennessee

Pasture and Hay Planting Improve Wades Branch Water Quality

Waterbody Improved

Runoff from pasture grazing cattle resulted in excess sediment entering and degrading a 7.2-mile segment of Wades Branch. This led to the listing of the segment as impaired in 1998 and subsequent years for siltation and habitat alteration. In 2002 and 2003, best management practices (BMPs), including pasture and hay planting, reduced sediment loads and resulted in the removal of Wades Branch from the 2004 303(d) list of impaired waters.

Problem

Wades Branch is located in the Stones River Watershed in Rutherford County, Ecoregion 71i. The 7.2-mile impaired segment, which runs from Stones River to the Dunaway Chapel Road Fork, was added to Tennessee's 2002 303(d) list of impaired waters for not meeting state water quality standards for siltation and habitat alteration to fully support its designated use classification of fish and aquatic life. The standard states that there shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life, and the instream habitat within each subecoregion shall be generally similar to that found at reference streams. Excess siltation alters the in-stream conditions by covering substrate with a layer of sediment that reduces habitat for benthic (bottom-dwelling) organisms that provide food for fish.

A siltation and habitat alteration total maximum daily load (TMDL) was completed for Wades Branch, by Tennessee's Department of Environment and Conservation, and approved by EPA in 2002.

Project Highlights

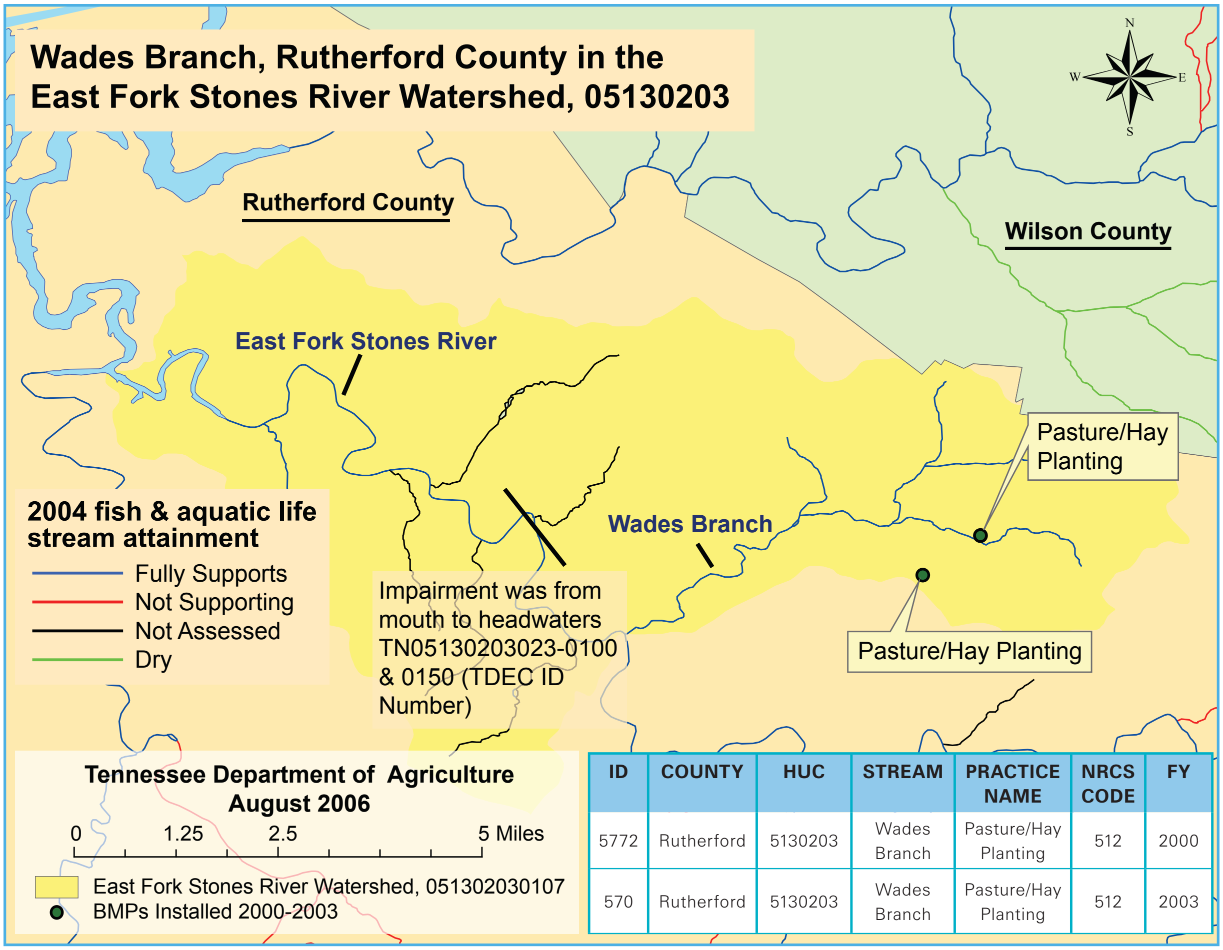
In 2000, 24 acres were renovated by replanting hay and pasture grasses within the watershed (Figure 1). In 2003, 21 acres of pasture lands along Wades Branch were renovated. The re-introduction of native plant species and more adaptable species not only helps to eliminate soil erosion and improve water quality, it also improves grazing livestock nutrition.

Results

Using EPA's rapid bioassessment protocol III (RBPIII), state biologists calculated a biological reconnaissance score (biorecon) for the Branch, which is used as a measure of compliance with water quality standards for the beneficial use of fish and aquatic life support. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1 to 15. A score of less than 5 is regarded as very poor. A score of more than 10 is considered good. The principal metrics used are the total macroinvertebrate families (or genera), the number of families (or genera) of mayflies, stoneflies, and caddisflies (EPT), and the number of pollution intolerant families (or genera) found in a stream. The biorecon results for Wades Branch indicated 11 EPT families (pollution sensitive species), 8 pollutant intolerant species, and 26 total families. Using this scoring system for biorecons, this stream segment scored a 15. The stream segment got a habitat score of 125, which is better than the established habitat goal for this region. The stream segment has improved greatly since last assessed and consequently resulted in the removal of this 7.2-mile segment of Wades Branch from the 2004 303(d) list of impaired waters.

Partners and Funding

The Rutherford County Soil Conservation District implemented the BMPs using $1,807.41 provided through cost-share from section 319 grant pool projects. In addition, the Tennessee Agricultural Resources Conservation Fund (ARCF) provided $2,000 in funding.



ID	COUNTY	HUC	STREAM	PRACTICE NAME	NRCS CODE	FY
5772	Rutherford	5130203	Wades Branch	Pasture/Hay Planting	512	2000
570	Rutherford	5130203	Wades Branch	Pasture/Hay Planting	512	2003

Figure 1. BMPs implemented in the East Fork Stones River Watershed (051302030107) 2000–2003

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Tennessee

Diverse Best Management Practices Control Urban and Agricultural Runoff

Waterbody Improved High nutrient concentrations from agricultural runoff, loss of biological integrity as a result of siltation, and habitat loss from streamside alteration caused Tennessee to put a 15-mile segment of West Sandy Creek on its 303(d) list of impaired waters in 2002 and 2004. Sources included agriculture use, bank and shoreline modification, and runoff from urbanized areas. To help address the problems, the Henry County Soil Conservation District (District) implemented 10 best management practices (BMPs), including grade-stabilization structures, water/sediment control basins, terrace construction, and hay and pasture plantings. The BMPs improved the water quality in the 15-mile segment, which was removed from the 2006 303(d) list of impaired waters.

Problem

West Sandy Creek is in the Kentucky Lake watershed in Henry County (Ecoregion 65E). The 15-mile impaired segment of West Sandy Creek extends from the West Sandy embayment in Kentucky Lake to the creek's headwaters. Tennessee added the creek to its 2002 and 2004 303(d) lists of impaired waters because of siltation, high nutrient concentrations, loss of habitat, and poor biological integrity. The state identified the sources of siltation as runoff from agricultural land and urban areas. Modification of the creek's shoreline led to its listing for habitat loss. This segment of West Sandy Creek was not meeting water quality criteria to fully support its designated use classification for fish and aquatic life. The state standards require that there be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits, or sludge banks of such size or character that could be detrimental to fish and aquatic life.

Project Highlights

The District implemented 10 BMPs in the Kentucky Lake watershed between 1999 and 2005. Pasture and hay planting, terrace construction, and installing water/sediment control basins helped to prevent excess silt from entering the creek. The terraces stabilized steep slopes along the creek and reduced runoff and soil erosion. Water/sediment control basins reduced stream bank scouring and gully erosion, trapped sediment, and reduced runoff, thereby improving water quality.

The District also created grade-stabilization structures throughout the watershed. These structures controlled the grade of the creek and helped prevent water from cutting into the side of natural or artificial channels. The practice was used in areas where the concentration and flow of water could potentially have caused gully erosion.

Three grade-stabilization structures and one terrace were installed in the drainage area of West Sandy Creek (Figure 1). The District also installed two water/sediment control basins and one grade-stabilization structure in the Spring Creek drainage area. Clifty Creek benefited from the installation of one water/sediment control basin. One grade-stabilization structure was installed on Chapel Branch, in the Kentucky Lake watershed.

Results

The BMPs implemented in the West Sandy Creek watershed reduced the level of nutrients and silt in the water and helped to prevent streamside erosion. Using the U.S. Environmental Protections Agency's (EPA's) rapid bioassessment protocol III (RBPIII), state biologists calculated a biological reconnaissance score (biorecon) for the West Sandy Creek, which is used to measure compliance with the state water quality standard for siltation. Biorecon is one tool used to recognize stream impairment as judged by species richness measures, emphasizing the presence or absence of indicator organisms without regard to relative abundance. The biorecon index is scored on a scale from 1 to 15. A score of less than 5 is regarded as *very poor*. A score of more than 10 is considered *good*. The principal metrics used are the total macroinvertebrate families, the number of families of mayflies, stoneflies, and caddisflies (collectively referred to as EPT, which is short for the order names Ephemeroptera, Plecoptera, and Trichoptera), and the number of pollution intolerant families found in a stream.

In 2004 biological sampling on West Sandy Creek, state biologists found 19 total families, 5 EPT families, and 1 pollutant-intolerant family. The biorecon score for the station was 13, which is in the *good* range. The data indicate that the stream is meeting water quality standards. Therefore, Tennessee removed this 15-mile segment of West Sandy Creek from its 2006 303(d) list of impaired waters.

Partners and Funding

The Henry County Soil Conservation District implemented the BMPs with $24,817 provided by the Tennessee state Agricultural Resources Conservation Fund through cost-share from Clean Water Act section 319 grant pool projects. In addition, local matching funds contributed $13,170.

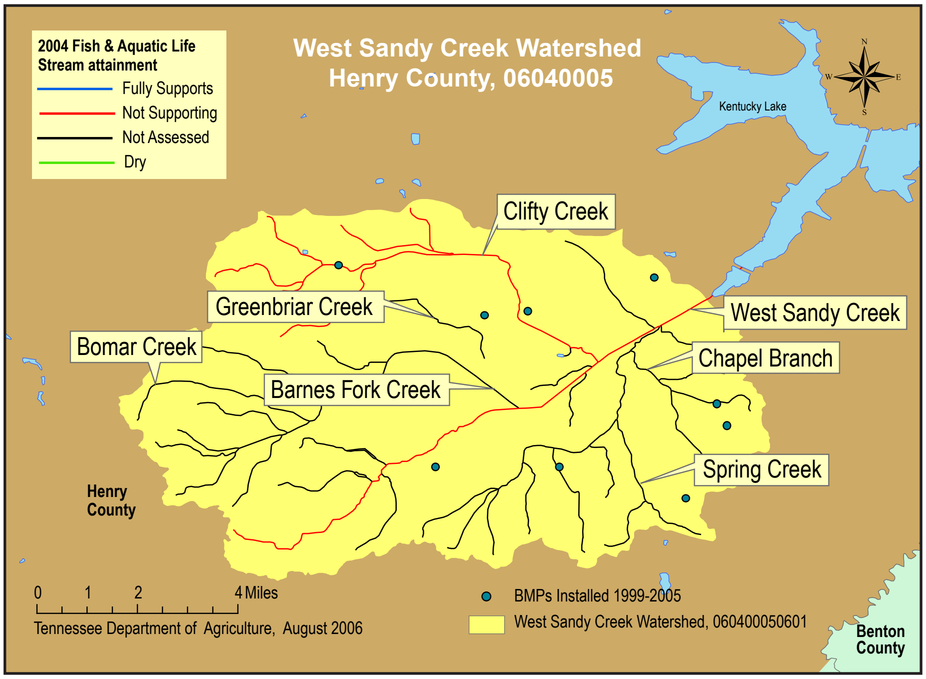

Figure 1. Location of BMPs installed along West Sandy Creek, TN.

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Improved Herbicide Management Restores Safety of Drinking Water Source

Waterbody Improved

Aquilla Reservoir is an important source of drinking water and recreation but was found to have excessive levels of the herbicide atrazine beginning in 1997. Project partners initiated efforts to reduce agricultural atrazine sources—and to a lesser extent, urban sources—in the watershed. As a result of technical assistance to corn and sorghum producers, using agricultural best management practices (BMPs), and educating urban residents, atrazine concentrations in Aquilla Reservoir declined by 60 percent. The waterbody now meets atrazine concentration standards, and in 2004 the Texas Commission on Environmental Quality (TCEQ) recommended that Aquilla Reservoir be removed from the state's 303(d) list of impaired waters for 2004.

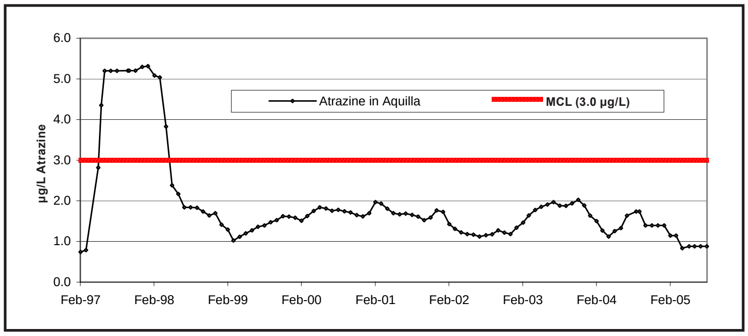
Problem

Aquilla Reservoir was built in 1983 for water supply, flood control, and recreation purposes. Approximately 10 miles southwest of the city of Hillsboro in east-central Texas, it controls drainage from a 255-square mile watershed. Corn and sorghum production comprise 40 percent of land use in the watershed. The reservoir is the sole source of water for the Aquilla Water Supply District's treatment plant.

Atrazine is an herbicide used by many corn and sorghum producers. It is also an ingredient in many residential lawn products. During the late 1990s, monitoring of finished drinking water showed that atrazine concentrations consistently exceeded state and federal drinking water standards mandating a maximum contaminant level (MCL) of 3 micrograms per liter (3μg/L). Three consecutive MCL violations led the state to place the reservoir on its 303(d) list of impaired waters in 1998.

The Aquilla Water Supply District took immediate steps to ensure public safety by reducing atrazine in drinking water through its treatment process. Meanwhile, TCEQ began an examination of atrazine loading to the reservoir.

The study found that all loading originated from nonpoint sources. This led TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) to establish a total maximum daily load (TMDL) for atrazine. EPA approved the TMDL in 2002. It required the reservoir to maintain a running annual average atrazine concentration not to exceed the 3μg/L MCL for 2 consecutive years. This would amount to a 25 percent atrazine load reduction.

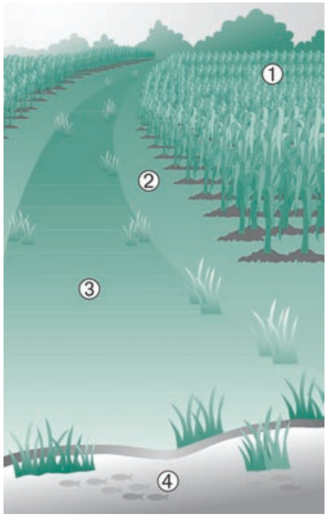


Atrazine concentrations in Aquilla Reservoir. Data represent running annual averages. Concentrations have steadily remained below the maximum contaminant level (MCL) since 1998. With the reservoir meeting the MCL requirement for more than 2 consecutive years, Texas has recommended that it be removed from the state's 303(d) list.

Project Highlights

The atrazine threat to drinking water triggered several coordinated projects to address urban and agricultural atrazine sources and restore water quality in Aquilla Reservoir. State, federal, regional, and local agencies collaborated to formulate and implement plans designed to reduce reservoir pollution, protect against new pollution sources, and monitor progress through water quality testing.

Agricultural producers, affected water supply companies, government agencies, and other stakeholders formed the Texas Watershed Protection Committee, which identified BMPs for use in the watershed and documented BMP adoption. Recommended BMPs included incorporating atrazine into the soil, filter strips, grade stabilization, grassed waterways, terraces, integrated pest management (e.g., targeted herbicide application), and education. The committee also worked to increase pesticide dealers' awareness of the problem and gain their assistance and support in solving it. Finally, corn and sorghum producers received technical and financial assistance to implement the BMPs.



Sample best management practices used to reduce atrazine loads. A field of corn (1) is cultivated. Atrazine is tilled into the soil, rather than simply applied on top of the ground. Farmers may install filter strips (2) between the field and an adjacent creek (4). A grassed waterway (3) may also be used to direct runoff to the creek while filtering out pollutants at the same time.

Project leaders also targeted urban areas for atrazine reductions. They prepared fact sheets about atrazine and alternative lawn management. Through the Texas Master Gardener program, they delivered television public service announcements about proper application and storage of herbicides and pesticides. Finally, they distributed fact sheets and general articles to local newspapers, to feature columnists, and at local meetings.

To measure the effectiveness of reduction efforts, TCEQ conducted monthly water quality monitoring. In addition, a private corporation that markets atrazine continued its voluntary pesticide monitoring program with the area's public water suppliers.

Results

These efforts led to a 60 percent atrazine load reduction, far exceeding the TMDL. As presented in the graph on the previous page, over 2 consecutive years of monthly reservoir sampling showed atrazine concentrations well below the 3μg/L requirement. The waterbody now meets atrazine concentration standards, and TCEQ has recommended that it be removed from the state 303(d) list.

TCEQ will continue collecting quarterly samples to monitor reservoir water quality. In addition, finished drinking water will continue to be monitored for compliance with the Safe Drinking Water Act.

Partners and Funding

TCEQ and TSSWCB led the atrazine reduction project and developed the TMDL. Various Texas Watershed Protection Committee activities were also vital to the effort. Led by the Texas Department of Agriculture, the committee consists of representatives from TCEQ, TSSWCB, Texas Agricultural Experiment Station-Blacklands Research Center, Texas Cooperative Extension, USDA-Natural Resources Conservation Service, Brazos River Authority, and Texas Farm Bureau.

Other partners included the Aquilla Water Supply District, Woodrow-Osceola Water Supply Corporation, Hill County Appraisal District, Hill County Blackland Soil and Water Conservation District, Sabine River Authority, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and Syngenta (formerly Novartis).

Since 1999, approximately $2.8 million in EPA section 319 and nonfederal matching funds have helped to support this restoration effort. In addition, the USDA-Natural Resources Conservation Service provided more than $1.9 million in cost-share funds between 1998 and 2003 to assist producers implementing BMPs in the watershed.

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Stream Restored through Improved Agricultural Practices and Erosion Control Work

Waterbody Improved

Sediment and nutrients in agricultural, roadway, and parking lot runoff degraded Adams Brook's biological communities and resulted in the waterbody being listed on Vermont's section 303(d) list of impaired waters. The installation of several best management practices, including improvements to a manure storage facility and erosion control work in several areas, resulted in improved water quality and allowed Adams Brook to be removed from the 303(d) list in 2004.

Problem

Adams Brook, a 3.5-mile stream in the central Vermont town of Randolph, is a tributary within the White River Basin. The Vermont Department of Environmental Conservation (VT DEC) classifies Adams Brook as a Class B water, a designation defined as "suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection."

In 1997, VT DEC monitored macroinvertebrates in Adams Brook using the EPT index, which measures the presence of pollution-sensitive aquatic insects in a waterbody. The index assumes that streams showing high EPT richness are less likely to be polluted than streams showing relatively low EPT richness in the same geographic region. In addition, VT DEC measured Adams Brook's biotic integrity (BI). Monitoring results from both indices indicated that Adams Brook failed to meet Vermont's Class B water quality standards for aquatic life support.

As a result of these findings, the state placed Adams Brook on Vermont's 303(d) list of impaired waters in 1998. Two VT DEC surveys and a concurrent White River Basin planning process indicated that the impairment was caused by nutrient and sediment loads coming from a nearby farm, poorly protected roadside ditches, and certain stretches of badly eroding streambanks.

Ditch near Adams Brook prior to being lined with rock. Rock lining reduced sedimentation into Adams Brook.

Project Highlights

In 1998, the U.S. Department of Agriculture and the Vermont Agency of Agriculture, Food and Markets worked with a local farmer to plug a leak in the farm's manure storage pit. They also expanded the pit size to better accommodate the volume and type of animal waste being generated. These actions helped to significantly reduce nutrient loading to the waterbody. Other activities helped to reduce sedimentation. In 2001, VT DEC secured the removal of an unauthorized culvert at an upstream tributary, thereby reducing the erosive force of stormwater in the channel. During

Geomorphic instability and an unauthorized culvert (upstream of the location in this photo) caused heavy erosion and the dumping of rock piles at the culvert shown here. Removing the unauthorized culvert helped to address the instability and reduce the water quality impacts on Adams Brook.

Adams Brook Biomonitoring Results

Sampling Site	Date	Assessment Rating	EPT	BI
1.5	9/16/1997	Fair	**15.0**	**4.77**
1.5	9/10/2001	Good	23.0	4.30
1.5	10/2/2002	Very good	19.0	2.14
		Class B Guideline	> 16.0	< 4.50

The table above compares Adams Brook biomonitoring results with Class B water guidelines. Data highlighted in bold indicate the waterbody's failure to meet aquatic life support biocriteria for Vermont Class B waters. These data led to Adams Brook being added to Vermont's 303(d) list in 1998.

the summer of 2002, the Vermont Agency of Transportation lined the eroding roadway ditches with stone and stabilized erosion at a nearby parking lot. All these actions contributed to bringing the stream into compliance with Vermont's water quality standards.

Results

Macroinvertebrate sampling in 2001 showed improvements in EPT taxa richness and BI, allowing Adams Brook to be assessed as "good" and attaining water quality standards. However, a waterbody cannot be removed from the state's impaired list until 2 years of biological monitoring data indicate compliance with water quality standards.

Consequently, Adams Brook was reassessed in 2002 and evaluated to be in "very good" condition, exhibiting only minor differences from nearby reference streams. The EPT richness remained well above the guideline for Class B waters (though down somewhat from the 2001 sampling period) and the BI value was significantly lower (better) than the previous 2 sampling years.

Metric improvements in 2001 and 2002 indicated that the stream community was under less stress and the brook had achieved compliance with Vermont water quality standards. As a result, Adams Brook was removed from the 303(d) list of impaired waters in 2004. The next scheduled monitoring year for the brook is 2006.

Partners and Funding

This project included financial and technical support from the U.S. Department of Agriculture Natural Resources Conservation Service and the Vermont Agency of Agriculture, Food and Markets for improvements to the animal waste storage facility. These improvements were also funded in part by the farm producer. The Vermont Agency of Transportation protected roadside ditches and established parking area erosion control measures. All the improvement and protection work was facilitated by the broader White River Basin planning process, which was managed by VT DEC and supported, in part, with approximately $50,000 in section 319 funding.

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Ski Resort Controls Erosion and Sedimentation, Restores Two Streams

Waterbodies Improved

Erosion and sediment runoff from ski area parking lots and roads degraded biological communities in Chase and Slide Brooks. As a result, Vermont placed the streams on its 303(d) list for aquatic life use impairments due to excessive sediment. The installation of new runoff controls and improved management practices brought the streams into compliance with Vermont's water quality standards, and the state removed both streams from its 303(d) list in 2004.

Problem

Chase and Slide Brooks, 1 and 3 miles long, respectively, flow through the Sugarbush Resort, a ski area and resort in the northern Vermont town of Fayston. The Vermont Department of Environmental Conservation (VT DEC) classifies both brooks as Class B waters—a designation defined as "suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection."

VT DEC monitored macroinvertebrates in both streams using several different techniques, including the EPT index—a measure of pollution-sensitive aquatic insects inhabiting a waterbody. Streams showing high EPT richness are less likely to be polluted than streams showing low richness in the same geographic region. In addition, VT DEC determined macroinvertebrate densities and the percentage of macroinvertebrates composed of pollutant-tolerant worms of the taxonomic class Oligochaeta.

In the mid-1990s biological monitoring found that a 0.5-mile segment of each stream did not fully meet Vermont's water quality standards for aquatic life. The segments had low EPT values, relatively low macroinvertebrate densities, and biotic communities with high percentages of oligochaetes. As a result, Vermont placed the segments on its 303(d) list of impaired waters in 1996. VT DEC attributed the impairments to sediment washing from nearby gravel parking lots and smothering benthic habitat in the streams.

Stream embeddedness—the extent to which sediment filled in gaps around rocks and cobbles in the Chase and Slide Brook streambeds—was 50–75 percent before the restoration effort. Embeddedness declined to 25–50 percent following restoration, representing significant habitat improvement.

Project Highlights

In compliance with Vermont's land development law (Act 250), which regulates expansions as well as new developments disturbing more than 10 acres in Vermont, the Sugarbush Resort prepared a comprehensive water quality remediation plan for the entire resort in the late 1990s. The remediation plan included a survey of all sites and sources believed to contribute to the water quality impairments, along with a list of recommended actions to address these sources.

The resort completed the recommended improvements between 2000 and spring 2002. The improvements included re-grading gravel parking lots and routing drainage through grass islands and sediment traps; enhancing the riparian buffer along Chase Brook; revegetating sections of work roads; cleaning, shaping, and matting swales; installing stone check-dams; replacing gravel with wood chips in heavily used areas; changing snow disposal practices to eliminate dumping in riparian zones; and instituting regular fall/spring maintenance of all the runoff control measures.

Results

Pre- and post-project biomonitoring results are shown in the accompanying tables. The tables compare results with the Class B water guidelines for aquatic life support. Data highlighted in bold indicate non-attainment of the Class B guidelines.

Chase Brook experienced a substantial decrease in the percentage of oligochaetes and increases in density and EPT indices. As a result, VT DEC assigned "very good" and "good" ratings to Chase Brook in 2000 and 2002, respectively. Both are passing grades under Vermont's water quality standards.

The monitoring results for Slide Brook indicated similar improvements. A decreased percentage of oligochaetes, combined with consistently strong values for the other indices, allowed VT DEC to assign Slide Brook ratings of "excellent" and "very good" in 2000 and 2002, respectively.

The data indicated that the remediation practices had reduced sediment delivery to the streams, improved stream habitat, and allowed Vermont water quality standards to be met in both streams by the fall of 2002. The state removed both streams from its 303(d) list in 2004. The streams are scheduled to be monitored again in late 2006.

Table 1. Chase Brook Biomonitoring Results

Sampling site	Date	Assessment rating	EPT	Density (individuals/m^2)	Individuals from Oligochaeta (%)
1.2	9/14/1993	Fair	**15.0**	357	10.6
1.2	9/20/1994	Fair	22.5	584	**23.8**
1.2	10/6/1998	Fair	19.0	493	11.7
1.2	9/18/2000	Very good	19.0	673	2.4
1.2	9/2/2002	Good	16.7	1253	1.4
		Class B Guideline	>16.0*	>300	<12.0

*Vermont Class B Guideline for EPT was 18.0 until the state changed it to 16.0 in 2002.

Table 2. Slide Brook Biomonitoring Results

Sampling site	Date	Assessment rating	EPT	Density (individuals/m^2)	Individuals from Oligochaeta (%)
0.7	10/21/1991	Good-Fair	24.0	762	11.7
0.7	9/14/1993	Fair	20.5	856	**12.6**
0.7	9/18/2000	Excellent	25.0	522	0.3
0.7	9/2/2002	Very good	21.7	944	1.2
		Class B Guideline	>16.0*	>300	<12.0

*Vermont Class B Guideline for EPT was 18.0 until the state changed it to 16.0 in 2002.

Partners and Funding

Sugarbush Resort contributed $11,500 to develop the remediation plan and $14,000 to implement it. The resort also spends $5,000–$7,000 annually for operation and maintenance. In addition, approximately $3,000 in section 319 funds supported stream monitoring work by VT DEC.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Vermont

Area Residents Keep Shelburne Beach Open
Unnamed Tributary to Shelburne Beach, VT

Waterbody Improved Bacteria leaking from residential septic systems caused exceedances of Vermont's *E. coli* criteria in a tributary to Shelburne Beach, resulting in occasional beach closures. As a result, Vermont placed the one-mile unnamed tributary on its section 303(d) list for *E. coli* in 1998. The Town of Shelburne identified the potential source of the bacteria, prompting improvements to a number of residential septic systems along the stream. Subsequent monitoring data showed that the stream and beach consistently met water quality standards, and the tributary was removed from the state's 303(d) list in 2004.

Problem

Shelburne Beach is a town swimming beach on a central portion of Lake Champlain in the town of Shelburne, Vermont. The state has classified the beach and the unnamed tributary to the beach as class B waters—a designation defined as "suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection."

The town monitors *E. coli* levels at the beach, including at a station at the mouth of the tributary, about 20 times a year during the swimming season, to check for compliance with Vermont's *E. coli* criteria. The criteria are 77 colony-forming units (cfu) per 100 milliliters for Class B waters. Among other purposes, the *E. coli* standard is designed to protect human health by preventing exposure to harmful levels of pathogens. Monitoring results for a number of years in the mid- to late 1990s indicated occasional exceedances of the *E. coli* standard at the monitoring station at the tributary mouth, causing occasional closures of the beach. The high *E. coli* counts resulted in the state's adding the unnamed tributary to the 303(d) list in 1998.

Coordinated efforts by area residents to control bacteria levels permit the continual enjoyment of Shelburne Beach

Project Highlights

In 1997 the town commissioned a study to find the source of the bacteria in the tributary, and the study identified six residential septic systems along the stream as the most likely source. Based on the findings of the study, the town encouraged the homeowners of concern to correct the deficiencies in their septic systems. Between 1998 and 2001, all six homeowners rebuilt their systems by installing new tanks and leach fields.

Results

The data summarized in Table 1 show that the *E. coli* standard was exceeded occasionally during the years 1996 to 1999. Although data are not available for 2000 and 2001, the data for 2002 and 2003 (following septic system improvements) show that the Vermont water quality standards for *E. coli* were met 100 percent of the time during those years. Accordingly, the state removed the tributary from the 303(d) list in 2004.

Partners and Funding

The restoration work in this case was funded by the Shelburne homeowners, who together spent approximately $90,000 to rebuild their on-site septic systems. The Town of Shelburne supported this work with seasonal bacteria monitoring and funding for the study that identified the bacteria source. Vermont Department of Environmental Conservation staff, funded with section 319 funds, provided some technical assistance to the town during the source-tracking phase.

Table 1. Summary of *E. coli* data at the mouth of the southern tributary to Shelburne Beach

Year	Number of samples taken throughout the season	Number of samples that exceeded Vermont's *E. coli* criterion of 77 CFU/100 mL	Average *E. coli* count for samples that exceeded criterion(CFU/100 mL)	Number of days beach was closed to swimming
1996	31	1	240	1
1997	28	3	197	1
1998	26	3	3,033	4
1999	16	1	130	0
2002	21	0	--	0
2003	21	0	--	0

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Vermont

Improved Management of Farm Drainage Restores Taft Brook

Waterbody Improved

Silage and milkhouse waste from a nearby farm degraded biological communities in a 0.1-mile section of Taft Brook. As a result, Vermont placed the stream on its 303(d) list for aquatic life use impairments due to excessive nutrients. Cooperation among the farm owner and other partners resulted in the construction of a waste storage system, which eliminated the cause of impairment. The Vermont Department of Environmental Conservation (VT DEC) expects to remove Taft Brook from its 303(d) list in 2006.

Problem

Taft Brook, a 6-mile stream in the northern Vermont town of Westfield, is a tributary within the Missisquoi River watershed. VT DEC classifies Taft Brook as a Class B water—a designation defined as "suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection."

In 1999, VT DEC monitored macroinvertebrates in Taft Brook using several different measures, including the EPT index—a measure of pollution-sensitive, aquatic insects inhabiting a waterbody. Streams showing high EPT richness are less likely to be polluted than streams showing low richness in the same geographic region. In addition, VT DEC evaluated Taft Brook's biotic integrity (BI), which measures the presence of pollution-tolerant species. High BI values characterize streams with poor water quality and dominated by pollution-tolerant species.

Biomonitoring revealed that a 0.1-mile segment of Taft Brook had low EPT richness and high BI. These findings, along with other biomonitoring results, put the segment in noncompliance with Vermont Class B water quality standards for aquatic life support. As a result, Vermont placed Taft Brook on its 303(d) list of impaired waters in 2000. VT DEC identified the drainage of nutrient-rich milkhouse and silage wastes from an adjacent farm as the likely cause of impairment.

Project Highlights

Technical assistance staff from the Winooski Natural Resources Conservation District contacted the owner and operator of the nearby farm in 1999. The farm owner then applied for and received cost-share assistance from the U.S. Department of Agriculture (USDA) and the Vermont Agency of Agriculture to construct a waste storage system. The concrete storage lagoon was installed later that same year, accommodating drainage from the milkhouse and silo areas as well as manure wastes. This eliminated the source of nutrients contaminating Taft Brook.

Results

In 2004, macroinvertebrate sampling found a decrease in pollution-tolerant species and an increase in sensitive species. The accompanying table shows the improvement in Taft Brook's biomonitoring results and compares them with Class B water guidelines for aquatic life support. Data highlighted in bold indicate the waterbody's failure to meet the Class B guidelines. As data from 2004 show, BI improved from 6.88 to 4.40, and EPT rose from 9.0 to 18.0—both within the guidelines for Vermont's Class B waters. Primarily because of the improvements to these key measures, VT DEC gave Taft Brook an overall assessment rating of "good," a passing grade under Vermont's water quality standards.

With the segment in compliance with aquatic life support criteria, VT DEC expects to delist Taft Brook in 2006. The waterbody is scheduled to be monitored again in 2009.

Partners and Funding

Entities contributing to the design and construction of the waste storage facility included the USDA, which provided $40,000 in cost-share funding; the Vermont Agency of Agriculture, which provided $26,000 in cost-share assistance; and the farm owner, who contributed $12,000. The Winooski Natural Resources Conservation District used $500 in section 319 funding to provide outreach and technical assistance to the farmer. In addition, approximately $2,000 in section 319 funding supported stream monitoring by VT DEC staff.

Taft Brook Biomonitoring Results

Sampling site	Date	Assessment rating	EPT	BI
0.1	9/9/1999	Poor	**9.0**	**6.88**
0.1	10/26/2004	Good	18.0	4.40
		Class B Guideline	> 16.0	< 4.50

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Vermont

Cleanup of Leaked Petroleum Restores Whetstone Brook

Waterbody Improved

Oil leaking from a nearby underground storage tank caused sheens and degraded biological communities in Whetstone Brook. This resulted in the state placing the waterbody on its 303(d) list in 1998 for aesthetic and aquatic life support use impairments. Project partners removed the storage tank and much of the leaked oil from the area. Several years later, biological assessments showed that Whetstone Brook once again met state water quality standards. Vermont removed the brook's aesthetic and aquatic life use impairments from its 303(d) list in 2004.

Problem

Whetstone Brook, a 7-mile stream in the southern Vermont town of Brattleboro, is a tributary within the state's Lower Connecticut River Basin. The Vermont Department of Environmental Conservation (VT DEC) classifies Whetstone Brook as a Class B water—a designation defined as "suitable for bathing and recreation, irrigation and agricultural uses; good fish habitat; good aesthetic value; acceptable for public water supply with filtration and disinfection."

In 1990 citizens and VT DEC staff first observed oil sheens in a 0.2-mile segment near the mouth of the brook. The following year, VT DEC located the petroleum source—a leaking underground storage tank at a nearby gas station. Cleanup efforts began immediately.

VT DEC monitoring staff member taking field notes on Whetstone Brook. Monitoring is scheduled to resume in 2008.

The leak and residual groundwater contaminant plume created an aesthetic nuisance and impaired aquatic life for several years. VT DEC monitored macroinvertebrates in Whetstone Brook using the EPT index—a measure of pollution-sensitive, aquatic insects inhabiting a waterbody. Streams showing high EPT richness are less likely to be polluted than streams showing low richness in the same geographic region. In addition, VT DEC evaluated Whetstone Brook's biotic integrity (BI), which measures the presence of pollution-tolerant species. High BI values characterize streams with poor water quality and dominated by pollution-tolerant species.

Monitoring results indicated that Whetstone Brook failed to meet Vermont's Class B water quality standards for aesthetics and aquatic life support. As a result, Vermont placed Whetstone Brook on its 303(d) list of impaired waters in 1998. VT DEC identified oil/grease as the primary cause of impairment.

Project Highlights

Once VT DEC identified the pollution source, the agency and gas station owner quickly initiated work to remove the storage tank and recover much of the leaked oil. By 1996, they had removed the storage tank and—with the help of a soil vapor extraction system—up to 4,000 gallons of oil from the surrounding soil and groundwater.

Even with the cleanup effort, however, residual petroleum in contaminated groundwater continued seeping into the brook until late 1999. VT DEC continued to monitor biological communities, look for oil sheens, and measure oil seepage along the streambank.

Results

The accompanying table compares key Whetstone Brook biomonitoring results with Class B water guidelines. Data highlighted in bold indicate the waterbody's failure to meet aquatic life support biocriteria for Vermont Class B waters. These data led to Whetstone Brook being added to Vermont's 303(d) list in 1998.

The monitoring team reassessed the segment in 2002 and found significant biological improvement. However, before 2004 (when Vermont revised its listing methodology for impaired waters), a waterbody could not be removed from the state's impaired list until 2 years of biological monitoring data showed compliance with water quality standards. Such compliance was confirmed in 2003. The EPT richness, BI values, and other biological indicators for both years remained well within the Class B guideline. In addition, the team found no evidence of oil sheens either year.

Because of these findings, VT DEC concluded that oil/grease no longer impaired Whetstone Brook's aesthetic and aquatic life uses. As a result, Vermont removed the waterbody from its 303(d) list in 2004. Whetstone Brook is scheduled to be monitored again in 2008.

Partners and Funding

Remediation costs for this effort totaled $440,000, with $430,000 coming from Vermont's Petroleum Cleanup Fund and the remainder from the service station owner. VT DEC spent another $68,000 on the groundwater investigation that tracked the leaking oil to its source. In addition, approximately $3,000 in section 319 funding supported the participation of agency monitoring staff.

Whetstone Brook Biomonitoring Results

Sampling site	Date	Assessment rating	EPT	BI
0.2	9/15/1998	Fair	**17.0**	**4.56**
0.2	9/17/2002	Very good	23.0	2.78
0.2	9/11/2003	Very good	20.5	3.33
		Class B Guideline	> 16.0*	< 4.50

* In 1998, the Class B Guideline for EPT was 18. Vermont changed the guideline to 16 in 2002.

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Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

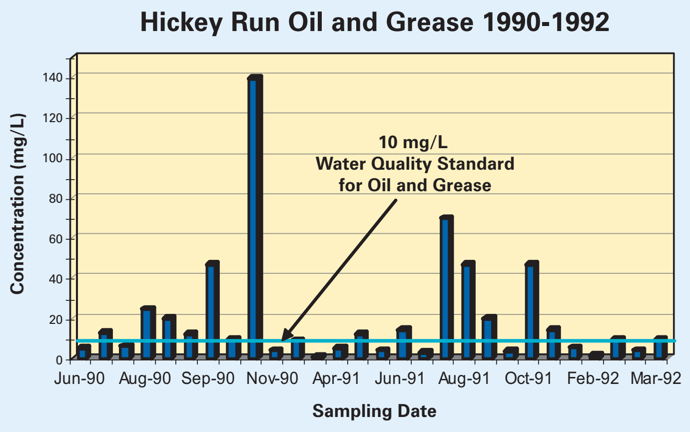
District of Columbia

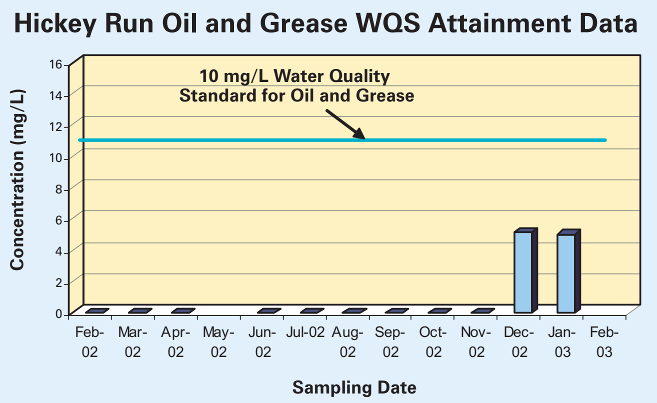
Oil and Grease Water Quality Goals Achieved in DC Area Stream

Waterbody Improved Illegal oil and grease dumping has historically plagued Hickey Run, a tributary of the Anacostia River approximately 1 mile downstream of the Washington, DC–Maryland border. As a result of extensive outreach efforts targeting the major sources of oil and grease—including local automotive repair shops—Hickey Run was removed from the 303(d) impaired waters list for oil and grease.

Problem

Land use in the Hickey Run watershed is largely composed of industrial and manufacturing uses, including a number of transportation-related facilities and automotive repair shops. The stream has been historically plagued by oil and grease from illegal dumping, and also during rain storms as oil and grease from surrounding parking lots, roads, and bridges flush into the storm sewer system, often overflowing directly into the stream. In 1996 Hickey Run was included on the DC 303(d) list for oil and grease, PCBs, and chlordane. In 1998 organics and bacteria were added to the list of pollutants impairing Hickey Run.





These graphs illustrate an 88 percent reduction in oil and grease that has led to the removal of Hickey Run from the 303(d) list of impaired waters.

Project Highlights

In 1998 the DC Department of Health (DOH), Environmental Health Administration, developed a total maximum daily load (TMDL) for oil and grease calling for a reduction in point source loads by 89 percent and nonpoint source loads by 30 percent. The TMDL set the overall reduction goal at 77 percent of existing oil and grease loads. Because the automotive repair shops were an easily recognizable source of oil and grease in Hickey Run, the DOH reached out to them through the Environmental Education Compliance of Auto Repair Shops (EE-CARS) Program. Businesses were provided educational resources, comprehensive surveys, and follow-up visits. The industry responded by reducing the amount of oil and grease entering Hickey Run by an even larger percentage than what the TMDL required.

In addition, in January 2004 the DC DOH, Environmental Health Administration, DC Water and Sewer Authority (WASA), and USDA Agricultural Research Service (ARS) signed a Memorandum of Understanding (MOU) that outlined the responsibilities of each organization in the cleanup. The MOU calls for the installation of a debris/floatables and oil/grease removal system that would be designed and constructed by the ARS in collaboration with the DOH and WASA. As effective as outreach has been, the proposed system will ensure that oil and grease will not degrade Hickey Run in the future for storm events of half an inch or less. Industry around Hickey Run faces high employee turnover, making technological control beneficial in protecting the waterbody from the impacts of poor shop management practices, intentional dumping incidents, and infrequent, but significant spills. Construction is expected to begin in 2006.

The DC government, in partnership with ARS, is also developing a restoration plan to address other problems in the Hickey Run watershed. The stream experiences unnaturally high flows during storm events—due to large areas of paved or otherwise impervious surfaces—resulting in severely eroded stream banks and channels. The lowest mile of the stream currently loses 1,100 tons of sediment per year. The U.S. Fish and Wildlife Service (USFWS) finished a comprehensive assessment of Hickey Run and its tributaries in December 2004 and is now preparing a plan intended to mitigate the damage and restore the stream by using natural channel design. Implementing the plan will produce 850 feet of natural channel design, resulting in reduced sediment loss, improved stream functioning, and increased wildlife habitat.

Results

Water quality data obtained in 2002 suggest that implementation efforts reduced overall oil and grease loading to Hickey Run by 88 percent compared to loading amounts reported in 1998. This result exceeds the 77 percent total reduction goal established by the TMDL. The District of Columbia 2002 and 2003 Discharge Monitoring Reports indicate that Hickey Run is achieving water quality goals for oil and grease levels less than 10 mg/L. As a result, Hickey Run has been removed from the 303(d) list of impaired waters for oil and grease.

Partners and Funding

The USDA's U.S. National Arboretum, National Park Service, District of Columbia WASA, USDA ARS, U.S. Environmental Protection Agency Region 3, and Government of the District of Columbia all contributed to the success of oil and grease load reductions in Hickey Run. With the assistance of section 319 funding, almost $2.2 million is allocated for the design and construction of the debris/floatables and oil/grease removal system. Of the USFWS and section 319 funding that DOH has received, $234,040 was spent on creating the design plans for the restoration project and $115,370 was spent on assessing the water quality.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
West Virginia

North Fork Potomac Watershed Farmers Improve Water Quality

Waterbody Improved

The North Fork of the South Branch of the Potomac River is a scenic trout stream in the headwaters of the Potomac River in northeastern West Virginia. Water in the North Fork had high levels of fecal coliform bacteria, primarily from agricultural runoff from beef and poultry farms. Over 85 percent of farmers in the watershed worked together to construct animal waste storage facilities, establish riparian buffers, and implement a range of other best management practices (BMPs) at the farms. As a result, the stream now meets its designated use and is no longer impaired by fecal coliform bacteria.

Problem

In the early 1990s signs of poor animal waste management practices became evident in the North Fork Potomac watershed. Algae blooms appeared in streams, and high bacteria counts were common. These changes corresponded to a significant increase in the poultry industry. Between 1993 and 1996 alone, the number of poultry farms doubled. A U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) study found that farmers were improperly storing litter from chicken houses and overapplying manure to fertilize their soils. A test program by the U.S. Geological Survey (USGS) confirmed that several streams were being polluted by fecal bacteria and also found that the highest levels of pollution were in areas with the highest number of feedlots and poultry houses. In 1996 several streams of the South Branch watershed, including the North Fork, were listed on West Virginia's 303(d) list for impairments due to fecal coliform bacteria, and it was determined that a 36 percent reduction from agricultural land was necessary in the North Fork watershed for the stream to achieve water quality standards.

Before
An animal feedlot that allowed runoff of contaminants into the nearby stream.

After
A new animal feedlot that is covered and has a concrete pad and adequate buffer has been installed.

Project Highlights

Cleanup activities first began in the watershed in 1993 when it became a part of the USDA Water Quality Initiative to address water pollution from farms. Section 319 grants supported the funding of Conservation Agency staff for the Initiative, and NRCS supported a number of projects in the watershed throughout the 1990s and in 1998 began working with the North Fork Watershed Association to develop a watershed management plan that identified practices to lessen damage from flooding and improve water quality.

Since then, a range of BMPs have been established to help control runoff from feedlots and eliminate or reduce cattle access to the streams. To keep cattle out of the streams, farmers installed streambank fencing and developed alternative livestock watering facilities. Farmers also constructed roofs over feeding areas, as well as new animal waste storage facilities to provide shelter and prevent runoff. Other efforts focused on streambank restoration through stabilizing critically eroding areas and planting vegetation along the stream banks. In addition to supporting the implementation of many of these activities, section 319 grants funded a project coordinator for the West Virginia Conservation Agency, who conducted outreach activities and leveraged support from partners, which was critical to the overall success of the project.

Several other major initiatives in the watershed also contributed significantly to nutrient reductions. One is a nutrient management initiative funded by special USDA appropriations between 1993 and 2001. As a result of technical support, including soil testing, litter/manure analysis, and manure spreader calibration, nutrient management plans were developed for all poultry and most of the livestock farms in the watershed, which have helped to prevent over-application of manure and commercial fertilizers to crop and pasture land.

Initiatives focusing on poultry litter are also contributing to nutrient reductions in the watershed. Several actions have focused on transporting excess poultry litter either outside the region or to other farms that could utilize the litter as fertilizer to help prevent over-application. A poultry litter composting project also demonstrated how the production of high-quality, value-added compost from poultry waste can make it more valuable to outside markets.

Results

As a result of the combined efforts of the agricultural community, with over 85 percent of the farmers implementing BMPs, thousands of tons of poultry litter and cow manure are now being properly managed. Water quality monitoring shows significant declines in fecal coliform levels in the North Fork. As a result, the stream now meets its designated use and is no longer impaired by fecal coliform bacteria.

Partners and Funding

Twenty organizations worked together to improve the water quality in the North Fork Potomac watershed. In addition to individual farmers and landowners, partners included the North Fork Watershed Association; Pilgrim's Pride/Wampler-Longacre Foods; Potomac Headwaters Resource Conservation and Development Council; Potomac Valley Conservation District; Trout Unlimited; USDA's NRCS and Farm Service Agency; EPA; USGS; state agencies and departments of Conservation, Agriculture, Highways, Environmental Protection, and Forestry; West Virginia Farm Bureau; West Virginia Poultry Water Quality Advisory Committee; West Virginia Poultry Association; West Virginia University College of Agriculture and Forestry; and West Virginia University Extension Service.

Almost $1 million in section 319 funding supported a range of best management practices, as well as outreach and educational programs in the watershed. USDA contributed almost $550,000 to improve management practices, with the state providing additional funds. Other funding sources included a $250,000 appropriation from the West Virginia legislature to support initial project activities; Clean Water Act State Revolving Funds (as a source of low-interest loans to finance BMPs); and $45,000 from the Governor's office and a $30,000 grant from Wampler Foods to support the poultry litter transfer program.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
West Virginia

Trout Waters Restored from Acid Pollution

Waterbody Improved Two streams, Sugar Creek and Dogway Fork, designated as trout waters by West Virginia, were affected by acid rain deposition and did not meet the state's water quality standards for pH. The state listed both streams on its section 303(d) (impaired waters) list in 1998, 2002, and 2004.

West Virginia Division of Natural Resources (WV DNR) applied limestone sand into both streams to neutralize the acid in the waters. This treatment helped bring the streams' water pH back into compliance with water quality standards. The state removed sections of both streams from its impaired waters list in 2006.

Problem

Sugar Creek is a tributary of the Williams River in Pocahontas County. Dogway Fork is a tributary of the Cranberry River, spanning Pocahontas and Webster Counties, in the southeastern part of the state. Both ultimately drain to the Gauley River. For both streams, their most sensitive use designations are Trout Waters—waters that sustain year-round trout populations—and Water Contact Recreation, including swimming and fishing uses.

Sugar Creek and Dogway Fork were originally listed on West Virginia's 303(d) List of Impaired Streams in 1998 with pH water quality violations. The pH readings were typically 3.7 in Sugar Creek and 3.8 in Dogway Fork. The state's water quality criterion for the streams' use designations specifies a pH of 6.0–9.0.

Project Highlights

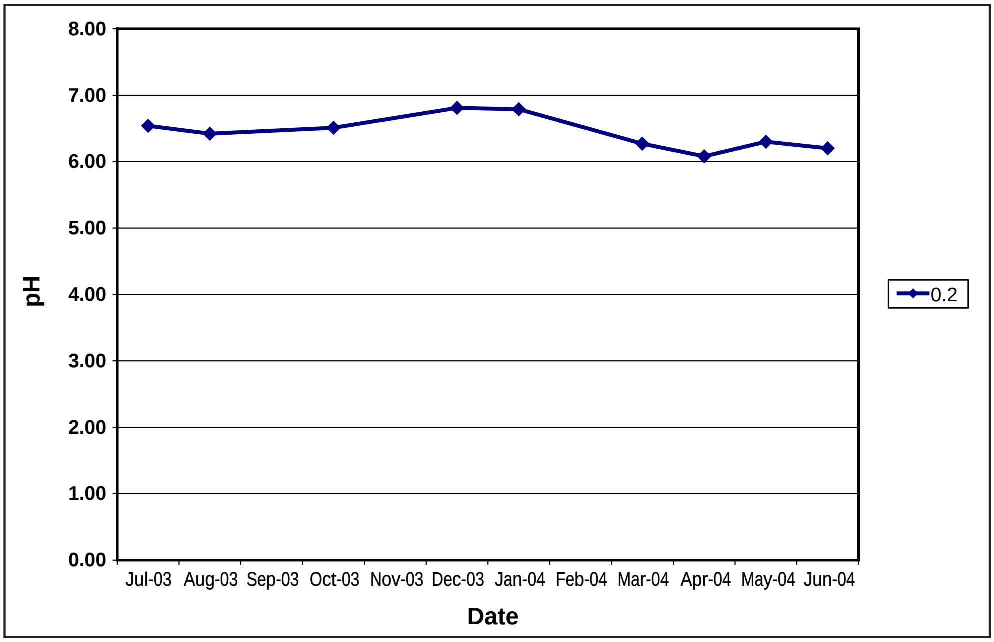
West Virginia's Department of Environmental Protection (WV DEP) identified these acid-impacted streams for water quality restoration efforts. WV DNR deposited fine limestone granules into the streams. Adding alkaline limestone sand helps raise the water's pH and neutralize the acidity. WV DNR is able to finance the long-term restoration of such acid-impacted water quality problems through funding set up through a portion of license fees and various legal settlement proceeds.

Results

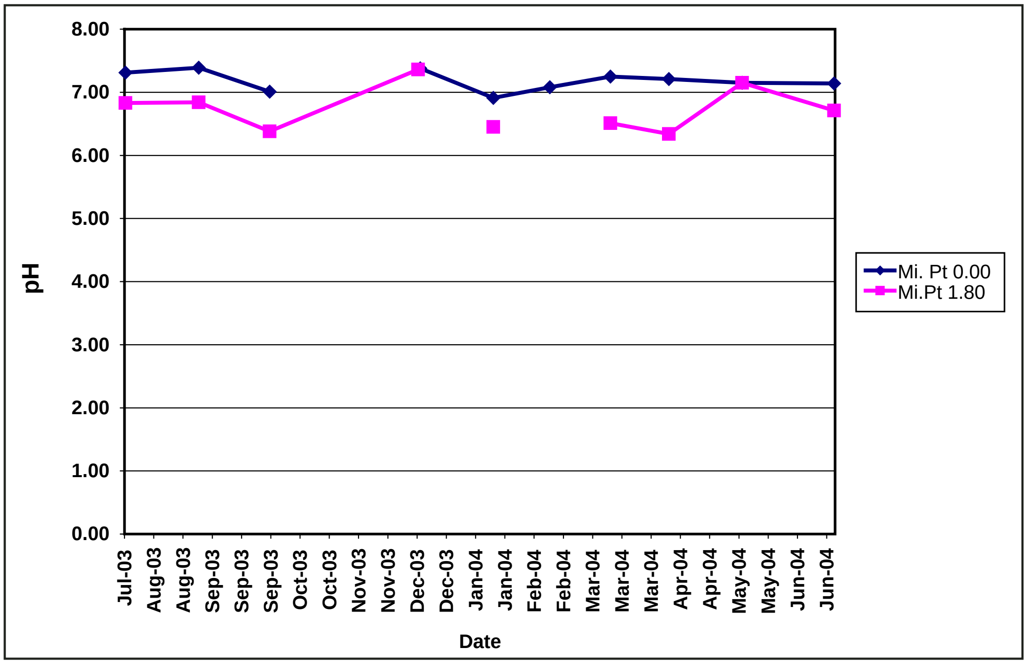
The limestone sand treatment raised the pH of the streams. Recent water quality monitoring has shown that the typical pH reading in Sugar Creek is now 6.4, and in Dogway Fork it is 7.0. After the limestone treatments, WV DNR began stocking trout and has maintained trout life in the streams. In total, 2.5 miles of Sugar Creek and 6.8 miles of Dogway Fork have been restored to viable trout fisheries.

Partners and Funding

WV DNR uses license fees and funds invested from various legal settlements for their limestone sands treatment program. WV DEP is the state's water quality management agency and assists WV DNR in identifying opportunities for restoration. WV DEP's Nonpoint Source Program has since worked with WV DNR to target stream restoration projects on priority nonpoint source pollution control sites in the Upper Buckhannon watershed.



pH data from WV for Sugar Creek mile point 0.2.



pH data from WV for Dogway Fork mile points 0.0 and 1.80.

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Section 319
NONPOINT SOURCE PROGRAM SUCCESS STORY
Wisconsin

Phosphorus Reductions in Bass Lake Restore Fishery

Waterbody Improved Livestock operations and other agricultural activities contributed to nutrient overenrichment and fish kills in Bass Lake in northeastern Wisconsin, forcing it to be added to the state's 303(d) list of impaired waters. The Marinette County Land and Water Conservation Department (LWCD) led an effort to reduce polluted runoff by installing state-of-the-art barnyard control practices combined with other in-lake treatment techniques that reduced phosphorus levels in the lake. The Bass Lake restoration project achieved total maximum daily load (TMDL) targets by reducing the average phosphorus concentrations from 490 μg/L to 10 μg/L, and the lake will be removed from the state's 303(d) list in the next listing cycle.

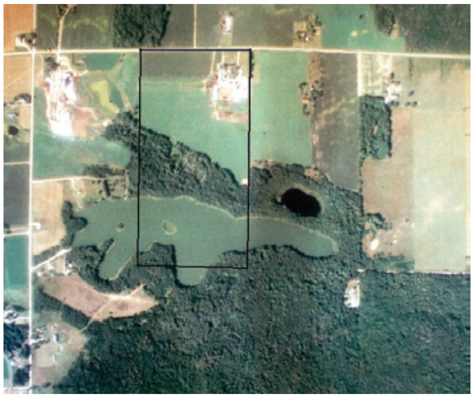
Problem

Bass Lake was placed on Wisconsin's 303(d) list of impaired waters for high phosphorus, low dissolved oxygen levels, and winter fish kills. Runoff from cropland, livestock barnyards, and nutrient accumulation in a wetland through which the inlet drained delivered high levels of nutrients and biological oxygen demand to the lake. Nutrient runoff caused heavy algae blooms, which covered the lake in the summer months, and dissolved oxygen concentrations fell to zero in the winter months when ice covered the lake. Low dissolved oxygen concentrations caused fish kills and decimated the sport fish population.

Bass Lake just after alum treatment, which helped reduce phosphorus in the lake.

Project Highlights

Marinette County LWCD spearheaded an effort to work with two livestock operations, with a combined total of 700 animal units, identified as the major sources of phosphorus entering the lake. LWCD worked with landowners to install state-of-the-art barnyard control practices such as manure storage facilities, clean water diversions, and roof runoff controls. Eventually, one landowner chose to discontinue operations in his barnyard. Funds from the state stewardship program allowed him to put 2,000 feet of Bass Lake shoreline and 55 acres of cropland under permanent easement. The U.S. Fish and Wildlife Service aided in the installation of sediment basins and restoration of wetland areas to prevent further loading. The remaining livestock operation further reduced runoff from livestock areas by moving animals into a free stall facility where cows are kept indoors in large pens. A sediment control basin and a leachate collection system—designed to collect polluted runoff and pump it into the manure storage—were also installed on the farm to virtually eliminate pollution transport from livestock areas to Bass Lake. With support from the Wisconsin Department of Natural Resources (DNR), LWCD worked with a professional consultant to treat Bass Lake with alum during fall 1999 to break the cycle



About 2,000 feet of Bass Lake shoreline is under permanent easement. Box in photo identifies approximate location of easement boundary.

No fish kills have occurred in Bass Lake since best management practices were implemented, and the fish population appears healthy.

of internal phosphorus release from sediment on the lake bottom and to reduce phosphorus levels in the lake.

Results

The Bass Lake restoration project achieved TMDL targets by reducing the average phosphorus concentrations from 490 μg/L to 10 μg/L, and the lake will be removed from the state's 303(d) list in the next listing cycle. Farmers' participation in nutrient management planning should reduce nutrient delivery from cropped areas in the watershed even further.

The alum treatment dramatically reduced total phosphorus in Bass Lake. Without the high concentration of phosphorus to feed on, heavy blue-green algae blooms no longer cover the lake and water clarity continues to improve. Secchi disk readings have improved from less than 10 feet before the project to up to 20 feet during July 2004 after the alum treatment. No fish kills have been noted since the project, and the fish population appears healthy.

Partners and Funding

Marinette County LWCD led this effort and received assistance from the Wisconsin DNR, U.S. Department of Agriculture's Natural Resources Conservation Service, U.S. Fish and Wildlife Service, Town of Beaver, and landowners. Project costs are estimated at $696,100. The State Stewardship Fund provided $195,000 of that total through section 319 and the Lakes program for a conservation easement to abandon one barnyard operation. Section 319 funds were also used to implement best management practices, which accounted for approximately 40 percent of project costs. The Wisconsin DNR Lakes Partnership Program also provided support with Lakes Protection grants for project activities. Some Clean Lakes activities, now funded by Clean Water Act section 319 grants, were formerly funded under the section 314 Clean Lakes program. Among other things, the Lakes program helped pay for the alum treatment, along with local cost share.

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